GDAL
Present and Future

Frank Warmerdam
OSGeo / Google

Overview

- Introduction to GDAL/OGR
- GDAL Data Model
- Focus on Subdatasets
- HDF4
- HDF5
- NetCDF
- Discussion

Who am I?

- Worked at PCI Geomatics (1991-1998)
  - GeoGateway, EASI+, ImageWorks
- Founder of GDAL/OGR project
- Consultant (1998-2011, GDAL, MapServer)
- maintainer: libtiff, libgeotiff, PROJ.4
- Founding director OSGeo
- Now working in Geo at Google

GDAL/OGR Introduction

- Geospatial Data Abstraction Library
- Raster (GDAL) and Vector (OGR)
- read/write access to many geospatial formats
- Widely used (FOSS+proprietary): GRASS, MapServer, QGIS, FME, ArcGIS, G. Earth
- 13 years old
- 40+ commiters (perhaps 10 active)
- A project of OSGeo
- MIT/X Open Source license (non-reciprocal)

GDAL Features

- Coordinate systems around OGC WKT.
- Utilities for translation, warping, subsetting,...
- Efficient support for large images - tiling, overviews
- Written in C++ with C-linkage wrapper
- Language bindings: python, perl, c#, java,...

GDAL Formats

- Plain Raster: jpeg, png, gif
- Geospatial Files: GeoTIFF, .img, NITF
- Wavelet: jpeg2000, ecw, mrsid
- RDBMS: Oracle Raster, PostGIS Raster
- Web Service: WMS, WCS, OPeNDAP
- Radar: CEOS, Envisat
- Elevation: DTED, USGS DEM
- Containers: HDF4, HDF5, NetCDF
- Special: In-memory, VRT

Over 100 Formats

GDAL Data Model - Overview

Dataset:

- XSize/YSize (in pixels)
- Coordinate System
- Georeferencing (...)
- Metadata (...)
- Driver
- FileList
- Bands (0+)

GDAL Data Model - Bands

- XSize/YSize in pixels (same as Dataset)
- Pixel Type: Byte, UInt16, Int16, UInt32, Int32, Float32, Float64, and the complex types CInt16, CInt32, CFloat32, and CFloat64.
- Block Size (for efficient access)
- Metadata (...)
- Description
- Nodata pixel value
- Nodata mask band
- Category Names
- minimum and maximum value.
- offset and scale
- Raster Units (ie. "meters", "pascals").
- Color Interpretation (ie. red, grey, paletted)
- Color Table

GDAL Data Model - Georeferencing

- GeoTransform: Affine (regular,rotation, shear)
- Ground Control Points
  - pixel/line
  - geo x, geo y, elevation
  - name
  - use to create polynomial or thin plate spline transform
- RPCs (ratio of polynomials)
- Geolocation Grids (auxiliary grids of x/y)

GDAL Data Model - Georeferencing

```
Geolocation:
  LINE_OFFSET=0
  LINE_STEP=210
  PIXEL_OFFSET=0
  PIXEL_STEP=249
  SRS=PROJCS["UTM Zone 49, Northern Hemisphere",GEOGCS[...,UNIT["Meter",1]]
  X_BAND=1
  X_DATASET=HDF4_EOS:EOS_SWATH_GEOL:"AST_....hdf1":SurfaceRadianceSWIR:Longitude
  Y_BAND=1
  Y_DATASET=HDF4_EOS:EOS_SWATH_GEOL:"AST...hdf1":SurfaceRadianceSWIR:GeodeticLatitude
```

GDAL Data Model - Metadata

- string name/value pairs
- on dataset, and band objects
- segregated into subdomains
  - generic: default, IMAGE_STRUCTURE, RPC, GEOLOCATION, SUBDATASETS
  - driver specific: NITF_DES_METADATA, CGM
  - xml: xml:ESRI, xml:XMP

OGR - Features

- OGC WKT coordinate systems
- OGC geometry model
- commandline utilities for translation (ogr2ogr) and query (ogrinfo)
- SWIG bindings (python, C#, java, perl)
- (potentially) fast spatial query
- GEOS for geometry operations
- SQL:
  - OGR SQL for all formats
  - Passthrough SQL for RDBMS

OGR - Formats

GIS: Shapefile, MapInfo, ESRI Personal/File Geodatabase
CAD: DXF, DGN (pre-V7)
RDBMS: PostGIS, Oracle, MySQL, Ingres, MSSQL, ODBC
NeoGeo: KML, GeoJSON
Web Service: WFS, Fusion Tables
National: SDTS, NAS, NTF, TIGER/Line, Interlis
Misc: CSV, VRT, Memory

OGR Data Model - Datasource

- A list of layers
- Think "directory of shapefiles" or "Personal Geodatabase"
- No metadata
- No layer relationships

OGR Data Model - Layer

- Think Shapefile+DBF or Spatial Table in RDBMS
- Layer name

Defined set of attribute columns

- Geometry type (may be unrestricted)
- Coordinate System
- Collection of Features

OGR Data Model - Attribute

- field name
- type
  - Integer, Float, String
  - List of Integer, Float, String
  - Binary
  - Date
- width, precision (for formatting)

OGR Data Model - Feature

- Attributes matching definitions from Layer
- Attributes may be null
- Geometry
- Feature Style (string)
- Feature Id (32bit integer)

OGR Data Model - Geometry

- OGC Simple Features (like PostGIS)
  - Point
  - LineString
  - Polygon (contiguous area with holes)
  - MultiPoint
  - MultiLineString
  - MultiPolygon (discontiguous area)
  - GeometryCollection
- 2.5D (X, Y, Z at each location)
- Double precision

Quick Raster Tutorial?

http://trac.osgeo.org/gdal/wiki/UserDocs/RasterProcTutorial

Project Directions

- Grand Unification
- New OGC/ISO Simple Features
  - TINs
  - 2.5D official
  - Curves
- More Formats
- More Fixes

GDAL 2.0: Grand Unification

- Merge GDAL and OGR
- GDAL style metadata for OGR
- unified driver model - datasets with bands and layers

Current Activity

Even Rouault:

- Everything! Bugs, new drivers

Андрей Мигаль:

- GSoC: Image Correlator

Etienne Tourigny:

- NetCDF

Frank Warmerdam:

- PROJ.4 epoch support (places move in time!)
- Libtiff security

Questions?

See Also:

http://www.gdal.org/