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BYU CEEn 594R - GIS Programming

SnowExplorer

Technical Specifications and Software Design Document

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# TECHNICAL SPECIFICATIONS

The SnowExplorer software was built to find out the snow volume and snow-covered area for any polygon in the contiguous United States of America for any day between 2003 – present based on snow water equivalent grids from the National Snow and Ice Data Center (NSIDC) Snow Data Asimilation System (SNODAS) model. This software was built by Jiri Kadlec and William Garner to satisfy the Web Mapping Project requirement in the GIS Programming course taught by Dr. Dan Ames at Brigham Young University.

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## Hardware and Software Requirements

A Microsoft Windows operating system with at least 200 MB of available disk space and the .NET framework 4.0 or higher is required. We recommend using Windows 7, Windows 8 or higher. For using the “Get data from Internet” functionality, Internet connection is required.

### Third-party software AND DATA dependencies

The software is built using the DotSpatial library (<http://dotspatial.codeplex.com>). It also uses the SharpZipLib library (<http://icsharpcode.github.io/SharpZipLib/>) for extracting the SNODAS snow water equivalent tar.gz files. The snow data used by the software are downloaded from the National Snow and Ice Data Center (NSIDC) SNODAS website. The files are documented at: <http://nsidc.org/data/docs/noaa/g02158_snodas_snow_cover_model/index.html>

## Source code & installation

The complete source code, binaries and sample data of the SnowExplorer are available at the GITHUB repository: <https://github.com/SnowMappers/SnowExplorer>

To install the SnowExplorer:

1. Go to <https://github.com/SnowMappers/SnowExplorer>
2. Click the “Download ZIP” in the bottom-right corner of the website
3. After downloading the file **SnowExplorer-master.zip** right-click on the file, select “Properties” and select “Unblock”. The “Unblock” step may be necessary on some Windows systems that block executable files downloaded from the Internet.
4. Unzip the file SnowExplorer-master.zip into a writable folder
5. In the unzipped folder, go to SnowExplorer\SnowExplorer\bin\debug and double-click on the file **SnowExplorer.exe** to launch the program.

To get the source code:

1. Use a GIT client. We recommend using the free TortoiseGit software from: <http://tortoisegit.org>
2. After installing TortoiseGit, create a writable folder, right-click on the folder, and select GIT Clone…
3. Enter the clone URL <https://github.com/SnowMappers/SnowExplorer.git>

# SOFTWARE DESIGN

## Purpose

The purpose of the SnowExplorer is to find out the snow volume and snow-covered area for any polygon in the contiguous United States of America for any day between 2003 – present based on snow water equivalent grids from the National Snow and Ice Data Center (NSIDC) Snow Data Asimilation System (SNODAS) model.file structure. The software is written using the c# programming language using the Microsoft .NET framework library.

## Classes and Functions

The software consists of the following classes:

**frmMain**

This is the main form file. It contains the user interface layout definition and the button click event handlers and the map mouse event handlers. The MouseClick and MouseDoubleClick event handlers are responsible for managing the drawing of a polygon on the map. The PolygonF object is a FeatureSet object. It stores the drawn coordinates of the polygon, and serves as a data source for the snow polygon feature layer. An important object is the mapMain. This is the main map control.

**frmGetData**

This is the dialog form for getting snow data. There are two options: “Get data from Internet” and “Get data from File”. The class holds a reference to the mapMain object. When the data is retrieved, the frmGetData passes the layer to the mapMain object and closes itself. The “Get data from Internet” operation calls functions from the DataFetcher class.

**VolumeCalculator**

The class is responsible for snow volume and snow-covered area calculation. The input is a Raster object where the value of each cell represents the snow water equivalent in millimeters. Negative or “no data” values in the snow raster are assumed to be snow-free. If the spatial reference system of the raster object is unprojected (decimal degrees Latitude / Longitude), the cell area is calculated separately for each raster row, because the length of one degree of longitude decreases with increasing latitude.

**DataFetcher**

The data fetcher contains the logic for retrieving and extracting snow raster datasets from the Internet. The structure of the datasets is explained in detail on the SNODAS website: <http://nsidc.org/data/docs/noaa/g02158_snodas_snow_cover_model/index.html>

The files are stored in the FTP web page:

<ftp://sidads.colorado.edu/DATASETS/NOAA/G02158/>

There are two subfolders on the FTP: masked and unmasked. Our SnowExplorer software use the masked grids, which are masked to the U.S. boundary. For each day, the data is stored in a .tar compressed archive file that contains two .gz files for each SNODAS model variable. The name of the .tar file is such as: **SNODAS\_YYYYmmdd.tar** where **YYYY** is the year (for example 2015), **mm** is the month (for example 04) and **dd** is the day (for example 16).

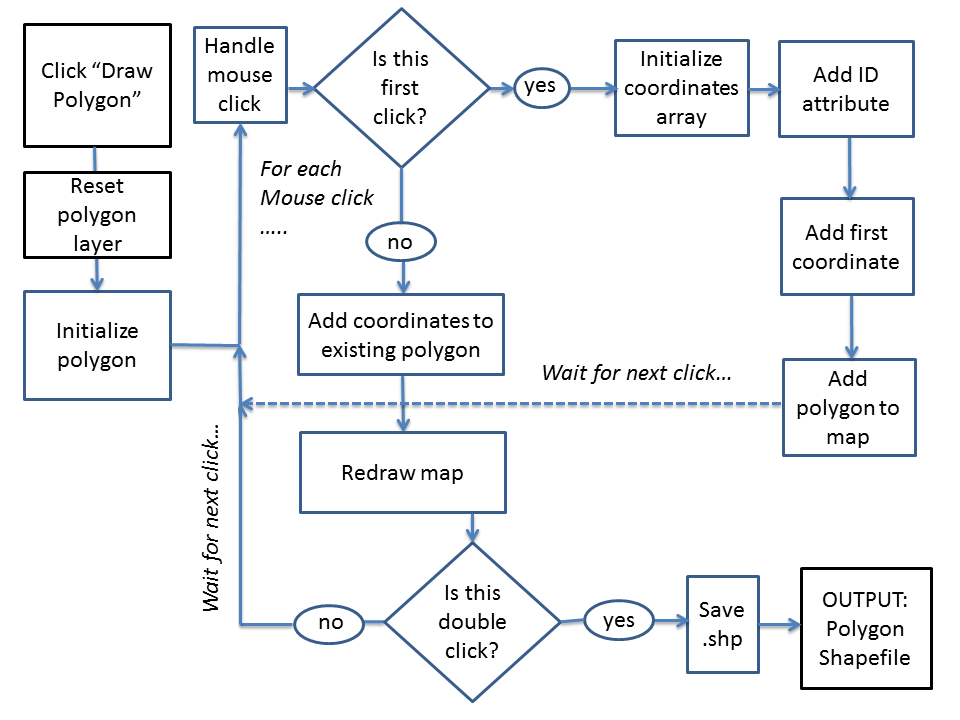
The steps for retrieving data in the DataFetcher are:

1. Given the date (day, month, year), create the URL of the .tar file
2. Download the .tar file and save it to a temporary folder on disk
3. Using the SharpZipLib library, extract two .gz files from the .tar file. The .gz file names must contain the product code “1034” which is the code for snow water equivalent
4. Using the SharpZipLib library, unzip the two .gz files. The extensions of the unzipped files are .hdr (header file) and .dat (binary data file).
5. Using the auxiliary class BinaryFileHelper, read the file into an array of 16-bit (short) integers. Because the SNODAS binary files are in big-endian format and the .NET framework uses the little-endian format, the BinaryFileHelper is used to read-in the data into a byte array and reverse the byte order in each integer.
6. The one-dimensional array of 16-bit short integers is converted to a two-dimensional Raster object. First, an empty Raster object is initialized with the number of rows, number of columns, cell size and bounds. The number of rows, number of columns, cell size and raster bounds (minimum and maximum latitude and longitude) are read from the .hdr file. Next, a loop is used to traverse each raster cell. For each raster cell, the index of the raw data one-dimensional array is found and the data value from the one-dimensional array is assigned to the cell.

## Flowchart: Drawing the Polygon

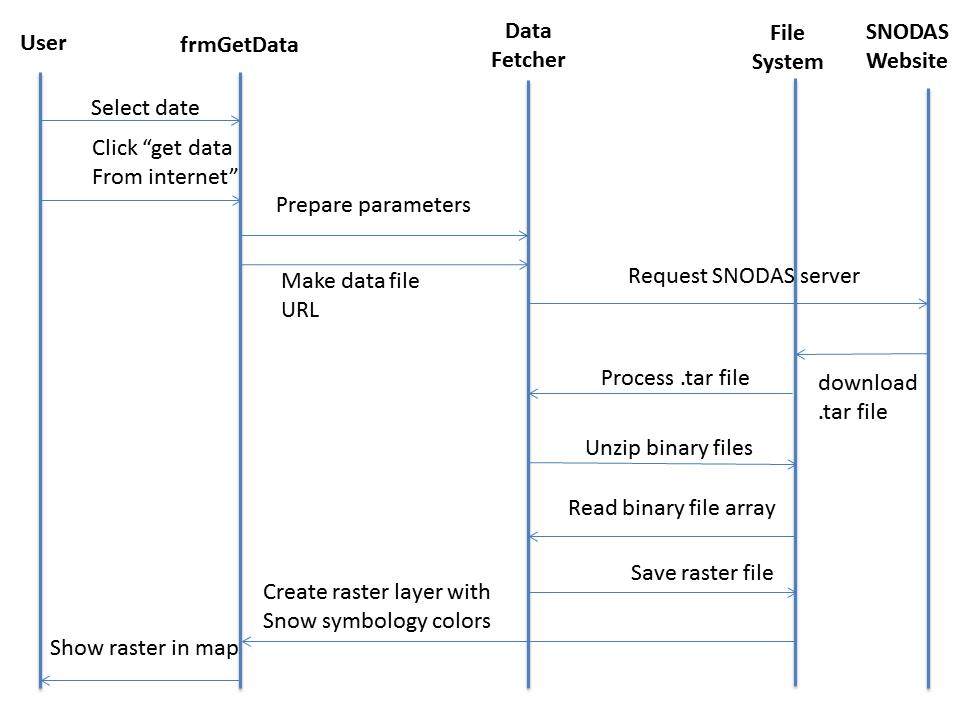
The first diagram shows the procedure for drawing the polygon on the map. When the user clicks the “Draw polygon” button, the polygon layer and polygon feature set are initialized. Any existing polygons from previous drawings are removed. The MouseClick event handler listens for the mouse click action. The first point of decision-making is: Is the mouse click a first click? If the mouse click is a first click, then the array of coordinates is initialized and an empty polygon is added to the map. On the other hand, if the click is a second click or greater, then the mouse coordinate is added to the first polygon and the map is forced to redraw. In each cycle, we also check if the mouse click was a double click. If the mouse click is a double click, then the first coordinate is re-added to the coordinate list, the listening to mouse events is stopped, and the polygon feature set is saved to a .shp file.

Diagram 1: Drawing polygon on the map



## User Interaction Diagram: Getting Data from Internet

The second diagram shows the actions after the user selects the “Get data from Internet” option from the frmGetData form. After the button click, the selected date and the data file URL parameters are passed to the data fetcher. The data fetcher issues a FTP web request to the SNODAS server which returns a zipped .tar file. The data fetcher extracts the binary data from the .tar file, it reads the binary array, and saves the values to a .bgd raster file. The frmGetData contains a function that reads the .bgd file, applies the snow color scheme to it, resulting in a RasterLayer that is displayed on the main map.



User Interaction Diagram 2: Downloading data from the Internet

## References

National Operational Hydrologic Remote Sensing Center. 2004. Snow Data Assimilation System (SNODAS) Data Products at NSIDC, [2003 - 2015]. Boulder, Colorado USA: National Snow and Ice Data Center. <http://dx.doi.org/10.7265/N5TB14TC>