LSDTopoTools: open-source software for topographic analysis

Introduction

LSDTopoTools is software for performing topographic analysis of landscapes, with applications in hydrology, ecology, soil science, and geomorphology.

Firstly, we should tell you that LSD stands for *Land Surface Dynamics*, and is named after Land Surface Dynamics research cluster in the School of GeoSciences at the University of Edinburgh.

Today we'll use the code to extract channel networks, get maps of slope and curvature across the landscape, and do some chi profile analysis.

The philosophy behind LSDTopoTools

LSDTopoTools is a software package designed to analyse landscapes for applications in geomorphology, hydrology, ecology and allied fields. It is not intended as a substitute for a GIS, but rather is designed to be a research and analysis tool that produces reproducible data. The motivations behind its development were:

1. To serve as a framework for implementing the latest developments in topographic analysis.
2. To serve as a framework for developing new topographic analysis techniques.
3. To serve as a framework for numerical modelling of landscapes (for hydrology, geomorphology and ecology).
4. To improve the speed and performance of topographic analysis versus other tools (e.g., commercial GIS software).
5. To enable reproducible topographic analysis in the research context.

The toolbox is organised around objects, which are used to store and manipulate specific kinds of data, and driver functions, which users write to interface with the objects.

Getting started

Installing LSDTopoTools

The preferred way of installing LSDTopoTools is using Docker, software for creating and managing containers. This method should work for anyone with Windows 10 Enterprise, Mac, or Ubuntu/Debian. If you have Windows 10 Home, please see our section on Windows Subsystem for Linux below.

To set up **LSDTopoTools** using Docker:

1. Download and install Docker for Windows (only works with Windows 10 enterprise), Docker for Mac, or Docker for Ubuntu or Debian. On MacOS we recommend installing docker using brew: `brew cask install docker`
2. Create an `LSDTopoTools` directory on your host operating system that you will share with the **LSDTopoTools** docker containers.
   a. We'll assume this is in `C:\LSDTopoTools` on Windows
   b. OR `\LSDTopoTools` on MacOS and Linux.
3. Pull the full **LSDTopoTools** container and run it with a linked volume:
   a. For windows:

```
$ docker run --rm -it -v C:/LSDTopoTools:/LSDTopoTools
lsdtopotools/lsdtt_alpine_docker
```

   b. For MacOS or Linux:

```
$ sudo docker run --rm -it -v /LSDTopoTools:/LSDTopoTools
lsdtopotools/lsdtt_alpine_docker
```

   c. Or if you have a different directory to LSDTopoTools data on your host machine:

```
$ docker run --rm -it -v /PATH/TO/YOUR/DATA:/LSDTopoTools
lsdtopotools/lsdtt_alpine_docker
```

4. Once you run this, you will need to run the script:

```
# Start_LSDTT.sh
```

Windows Subsystem for Linux

Some users have had difficulties getting Docker to install on Windows as it can require changing a setting in the BIOS. If this is the case, you can try to install the code natively using Windows Subsystem for Linux.

1. Firstly, download the Ubuntu app from Microsoft Store. If you can't find it, then you can also get it from this link. You might need to restart your computer as prompted following this step.
2. Launch the Ubuntu app by clicking on it from the Start menu. You will then be prompted to create a new user account and password - you can choose whatever you want for this, but make sure you remember it!
3. The first time you launch, make sure you update and upgrade your standard packages by typing:

```
sudo apt update && sudo apt upgrade
```

4. Now install the dependencies for LSDTopoTools:

```
sudo apt install -y build-essential git gdal-bin python-gdal libfftw3-dev cmake
```

5. Then make a new directory for the LSDTopoTools code and download it from GitHub:

```
mkdir LSDTopoTools && cd LSDTopoTools
git clone https://github.com/LSDtopotools/LSDTopoTools2.git
```

6. This will create a directory called `LSDTopoTools2` in your home. Navigate to this directory and run the start up script:

```
cd LSDTopoTools2
bash lsdtt_setup.sh
```

Get the workshop data

You can find all of the data you need for the workshop on GitHub. Let's clone this data (either on your Docker container or your Ubuntu subsystem). First, navigate to your LSDTopoTools directory (on Docker this is `/LSDTopoTools/` or on the Ubuntu app `~/LSDTopoTools/`) and then clone the Git repository:

```
git clone https://github.com/LSDtopotools/LSDTopoTools_workshop.git
```

This will create a directory called `LSDTopoTools_workshop`. Navigate into this directory and take a look at the files within it. During the workshop we will be analysing a 10 m DEM from Santa Cruz Island, one of the Channel Islands offshore of California.

#include::sections/channel_extraction.asc[]

#include::sections/slope_curvature.asc[]

#include::sections/chi_analysis.asc[]

#include::sections/visualisation.asc[]