Processing LiDAR data: Fusion tutorial

Douglas Bolton
Rory Tooke
Nicholas Coops

University of British Columbia
Tutorial Objectives

- Open/Visualize LiDAR data in Fusion
- Derive surface products (2 m)
  - Digital elevation model (DEM)
  - Digital surface model (DSM)
  - Canopy height model (CHM)
- Extract LiDAR data for polygons and plots
  - Calculate LiDAR metrics for plots
- Calculate gridded LiDAR metrics
  - Apply existing models in ArcGIS to derive biomass, volume, etc. from gridded metrics
- Learn to work with multiple LiDAR tiles
LiDAR data used in this tutorial

Discrete return LiDAR data collected in 2010 over the Malcolm Knapp Research Forest

- Collected by McElhanney Consulting Services Ltd using a ALS50-II Leica system
- Average of 3.1 pulses/m²
  - Multiple returns per pulse
- Aerial photos were collected on the same flight

Malcolm Knapp Research Forest

- UBC Research Forest
- Located in the Coast Western Hemlock biogeoclimatic subzone near Maple Ridge, BC
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Step 1: Extract probable ground returns (Groundfilter)

Step 2: Create surface from ground returns (GridSurfaceCreate)
Digital Surface Model (DSM)

Create a digital surface model (CanopyModel)
Create a digital surface model (*CanopyModel*)
Create a digital surface model (*CanopyModel*)
Digital Surface Model (DSM)

Visualization for
Malcolm Knapp Research Forest

Create a digital surface model (CanopyModel)
Create a digital surface model (CanopyModel)
Canopy Height Model (CHM)

Lidar visualizations produced with FUSION/LDA software – USDA Forest Service
Canopy Height Model (CHM)

Lidar visualizations produced with FUSION/LDA software – USDA Forest Service
Plot level analysis

Lidar visualizations produced with FUSION/LDA software – USDA Forest Service

Lidar Point Cloud for Alex Fraser Research Forest

Extract LiDAR data for plots (Clipdata)
Plot level analysis

Lidar Point Cloud for Alex Fraser Research Forest

Extract LiDAR data for plots (Clipdata)
Calculating Lidar metrics

Calculate Cover Metrics

Cover Above 2 m

Calculate metrics (Cloudmetrics)
Calculating Lidar metrics

Calculate Height Metrics

Mean Height

Calculate metrics (Cloudmetrics)

High Volume Site

Low Volume Site
Calculating Lidar metrics

Calculate Height Metrics

75th Percentile

Calculate metrics (Cloudmetrics)
Calculating Lidar metrics

Calculate Height Metrics

95\textsuperscript{th} Percentile

Calculate metrics \textit{(Cloudmetrics)}
Calculating Lidar metrics

Coefficient of Variation

Measure of the structural diversity

Calculate metrics (Cloudmetrics)

High Volume Site

Low Volume Site
**Plot Level Analysis**

**Lidar Metrics**
- 75<sup>th</sup> height percentile
- 95<sup>th</sup> height percentile
- Mean
- Standard deviation
- Coefficient of variation
- Cover above 2 meters

**Forest Attributes**
- Gross Stem Volume
- Basal Area
- Mean height
- Dominant height
- Loreys height
- Wood biomass
- Bark biomass
- Stem biomass
- Foliage biomass
- Branches biomass
- Crown biomass
- Total above-ground biomass

**Forest Attribute** = exp\((b_0 + b_1 \ln(x_1) + b_2 \ln(x_2)\ldots b_n \ln(x_n))\)
Calculating Gross Stem Volume

**Step 1:** Calculate gridded metrics

**Step 2:** Apply Statistical model
Model form we often use:
Attribute = exp\(b_0 + b_1 \ln(x_1) + b_2 \ln(x_2) + ... + b_n \ln(x_n)\) X BCF

Model to derive net volume \((m^3/ha)\) for Malcolm Knapp
Net Volume =
exp(-33.6579 + (2.0058 \times \text{Ln("Elevation_P95.asc")}) + (7.1162 \times \text{Ln("Elevation_Cover_at_2m.asc")})) \times 1.0872