CERFO

Centre d'enseignement et de recherche
en foresterie de Sainte-Foy inc.

Using AI to scale digital forest inventories

Several jurisdictions, including the province of New Brunswick, are currently developing a strategy for the digitalization of the forest sector. However, it is widely acknowledged that the upstream portion (digital inventories) is deficient to a point that benefits from developments of other segments, such as supply chain logistics, cannot materialize until inventories are significantly improved.
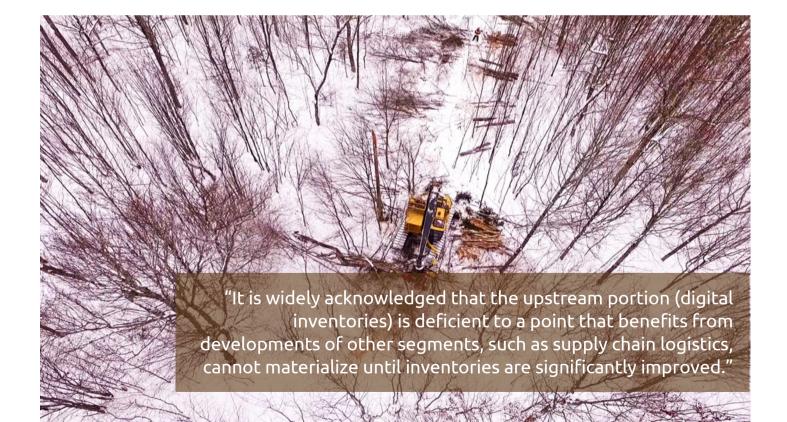
Forest inventories are traditionally carried out in the field and by photointerpretation. These two approaches are subject to interpretation and uncertainty and thus difficult to replicate and quantify. Moreover, they are time consuming and expensive. In an effort to improve forest inventories, more and more initiatives have focused on leveraging synergies between remote sensing and artificial intelligence (AI). Most applied research initiatives are aimed at accelerating and automating inventory processes while reducing uncertainty and improving replicability.

With this in mind, the Northern Hardwood Research Institute (NHRI) is collaborating with the Centre d'enseignement et de recherche en foresterie de Sainte-Foy Inc. (CERFO) to find solutions to those pressing issues. CERFO has been given the mandate to assist and

advise us in our efforts to accelerate the production of world-class precision forest inventories. CERFO is a leader in using AI to produce digital forest inventories. Their team has experience using these novel approaches, notably to map forest species from LiDAR and satellite data, to identify invasive alien species, or to estimate the diameter at breast height, tree height, density, structure, and volume of trees.

The main objective of the collaborative project will be to design an AI-based operational prototype to be integrated into an automated forest inventory platform. Specific objectives include:

- Design a process to use digital photointerpretation to produce training data for AI models
- Create an operational prototype for forest species prediction
- Build an operational prototype for detecting forest harvesting

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This platform will be built to test hypotheses and produce simple models that function at smaller scales and are limited to single images and under similar conditions. The outputs from this platform will consist of prototype models, lists of key variables and their weights, simple predictions of precision forest inventories, etc. The elaboration of a simple AI platform will allow our team to quickly produce data that can be promoted into a scale-up model.

CERFO intends to build on its experience in similar projects to propose innovative, efficient, and automated solutions. For several years, their team has been carrying out photointerpretation projects and collecting the reference data required to design these types of models. This established process consists of collecting information based on a well-defined framework. These data are essential to the design of reliable and efficient models and tools. The tools will be developed and adapted to meet NHRI's specific requirements.

The programming language used will be Python or R. Depending on the level of detail, it is desired to opt for machine learning models (Support Vector Machines, Random Forest, xgBoost, ExtraTrees) or deep learning (Convolutional neural network, Recurrent neural network, Vision transformer). The basic data used will be Sentinel-2, Planetscope and aerial images (New Brunswick government) and airborne LiDAR. The use of super-resolution images will be particularly interesting, especially for deep learning algorithms. It is proposed to develop a model adapted to each specific objective, to extract information formatted at the 20 x 20 m scale. Technology transfer and technical assistance will also be offered to NHRI team throughout the project through technical meetings and workshops.

The approach used to generate precision forest inventory features differs from most current initiatives that mainly rely on LiDAR data. While LiDAR-derived data is often fused with other sources in our modelling processes, the project will primarily rely on freely available high-cycle multispectral satellite data to overcome the shortfalls of laser scan data.

This acceleration project will strengthen NHRI's AI expertise and establish it as a leading player in the digitalization of the forest products value chain for the benefit of the private sector and the economy in general. It will also formalize its collaboration with CERFO, an applied research center in the Province of Québec who has a vast expertise in using AI for the development of forest inventories.

This novel approach, rooted in Agile management philosophy, is also aligned with NHRI's vision of leveraging its current and future intellectual property (IP) related to precision forest inventories, leveraging artificial intelligence (AI), remote sensing and the production of state-of-the-art training data.

MORE THAN A THEORETICAL CONCEPT...

NHRI-IRFN

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