Institut
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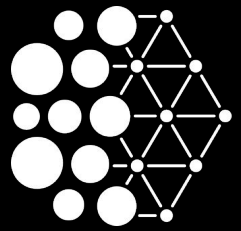
d'intelligence
artificielle



Mila

Horoma project

Semi-supervised forest canopy characterization

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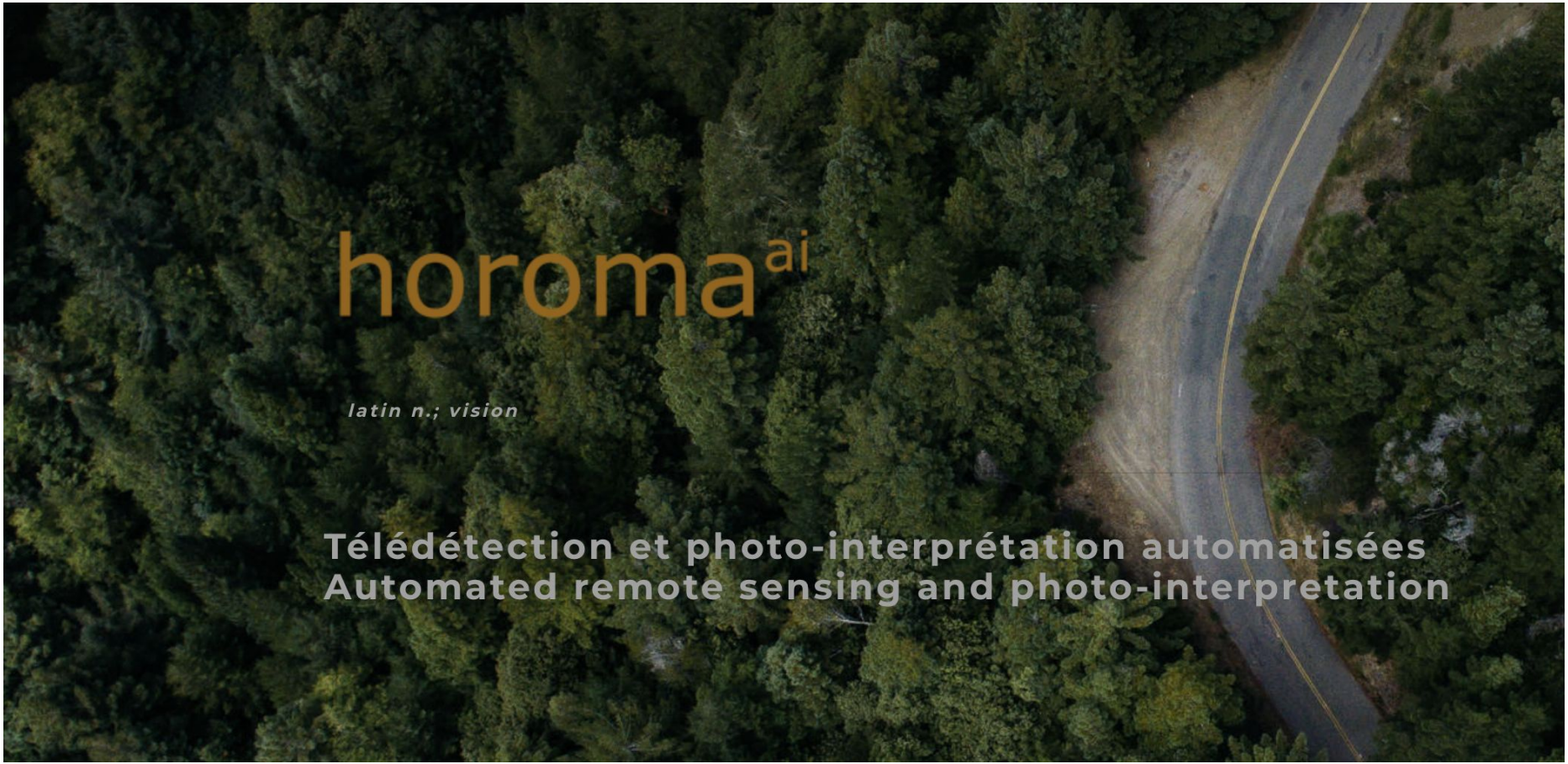
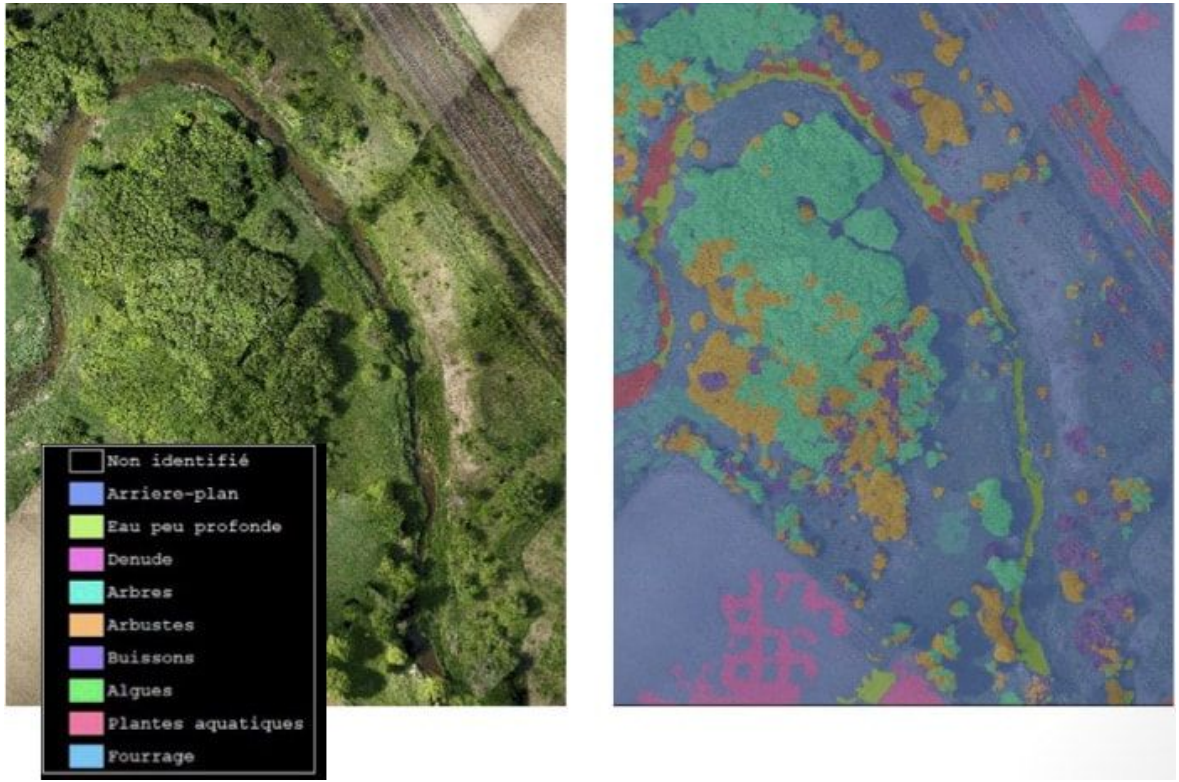
Mathieu Germain


horomaai
latin n.; vision
Télédétection et photo-interprétation automatisées
Automated remote sensing and photo-interpretation

Horoma - Example

Horoma - Example



Horoma project

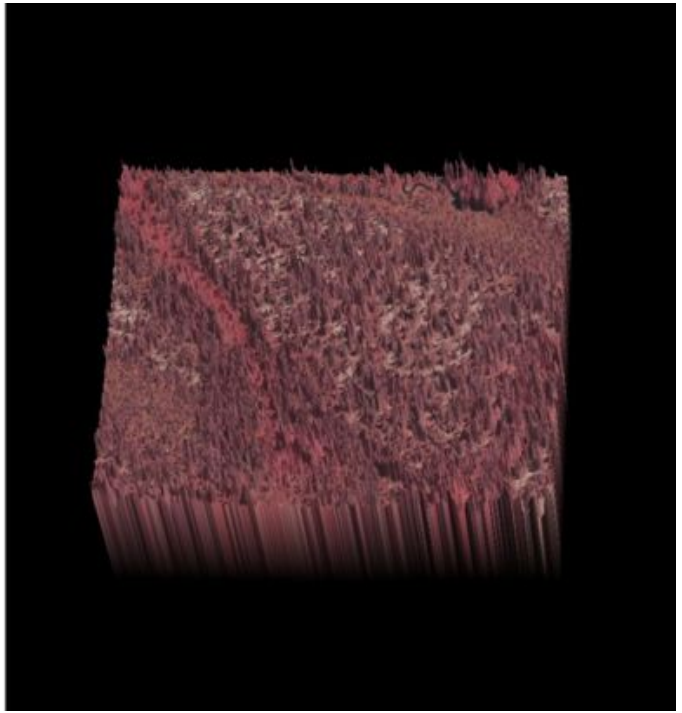
- **Task:** Analysis of images of forest canopy to determine:
  - Tree specie.
  - Tree density.
  - Tree height.

- **Main challenge:** Data labeling is made by human interpreters and is therefore costly and time consuming.

- **Goal:** Develop an unsupervised or semi-supervised machine learning system capable of predicting forest canopy properties with no or small amounts of labeled data.

Data (images)

- 3 Digital Surface Models (DSM) of forest areas in the Outaouais, a Western Quebec region.
- An image (or DSM) covers approximately 5km*3km (15km^2) of land, such that a single pixel represents an area of about 30cm*30cm.
- All images were taken during the same period of the year when trees are leafy (thus facilitating image labeling).



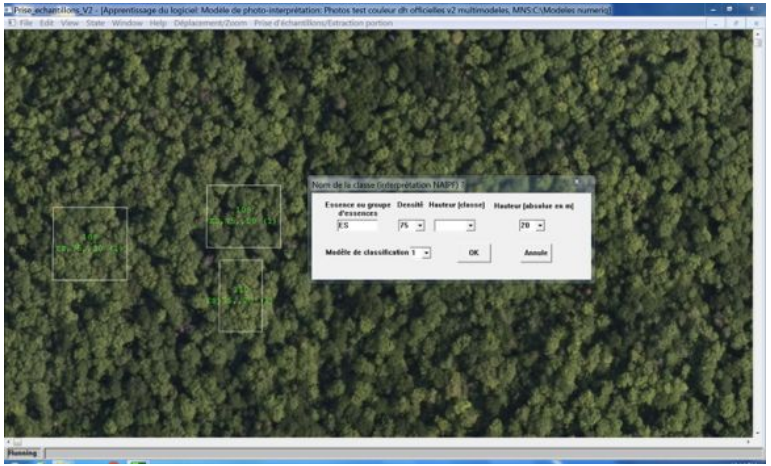
Data (pixel)

- Each pixel of an image has 4 values associated with it:
    - **RGB colors** (3 values). Those values are in [0, 255].
    - **Height** (1 value). The height values were obtained using photogrammetry and were georeferenced; they are measured w.r.t. the sea level.

Data (image labeling)

- Each image was labeled by a different human interpreter.

- Interpreters only labeled subsections of an image, with each subsection containing trees of the same overall specie, density and height (w.r.t the forest floor).

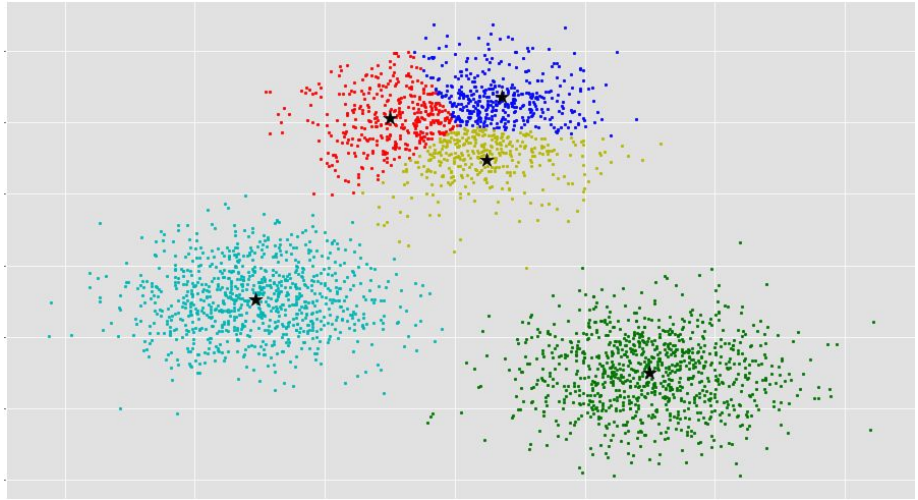


Data (image labeling)

- Tree density and height estimated by interpreters are approximate measurements.
- Interpreters base their measurements on the diameter and shape of treetops.
- Tree height measurement (which is rounded at 5m) is difficult to determine when there are no gaps in the image allowing the expert to see the forest floor.

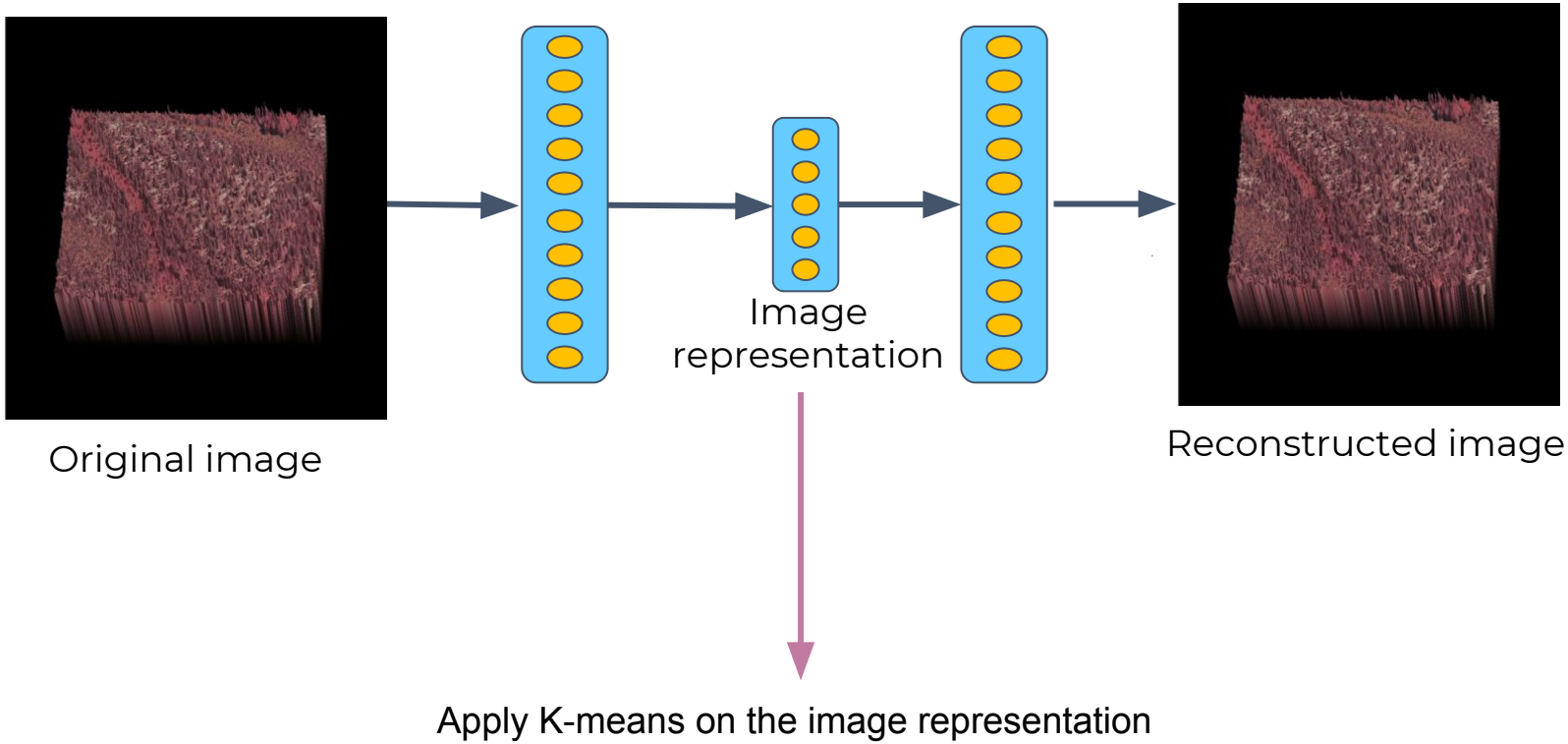
Unsupervised learning (Block 1)

- Cluster the data in a way to group patches with similar properties together.
- Can use K-means as a starting point.
- But… what is K-means applied to? Original images or a more informative representation of images?

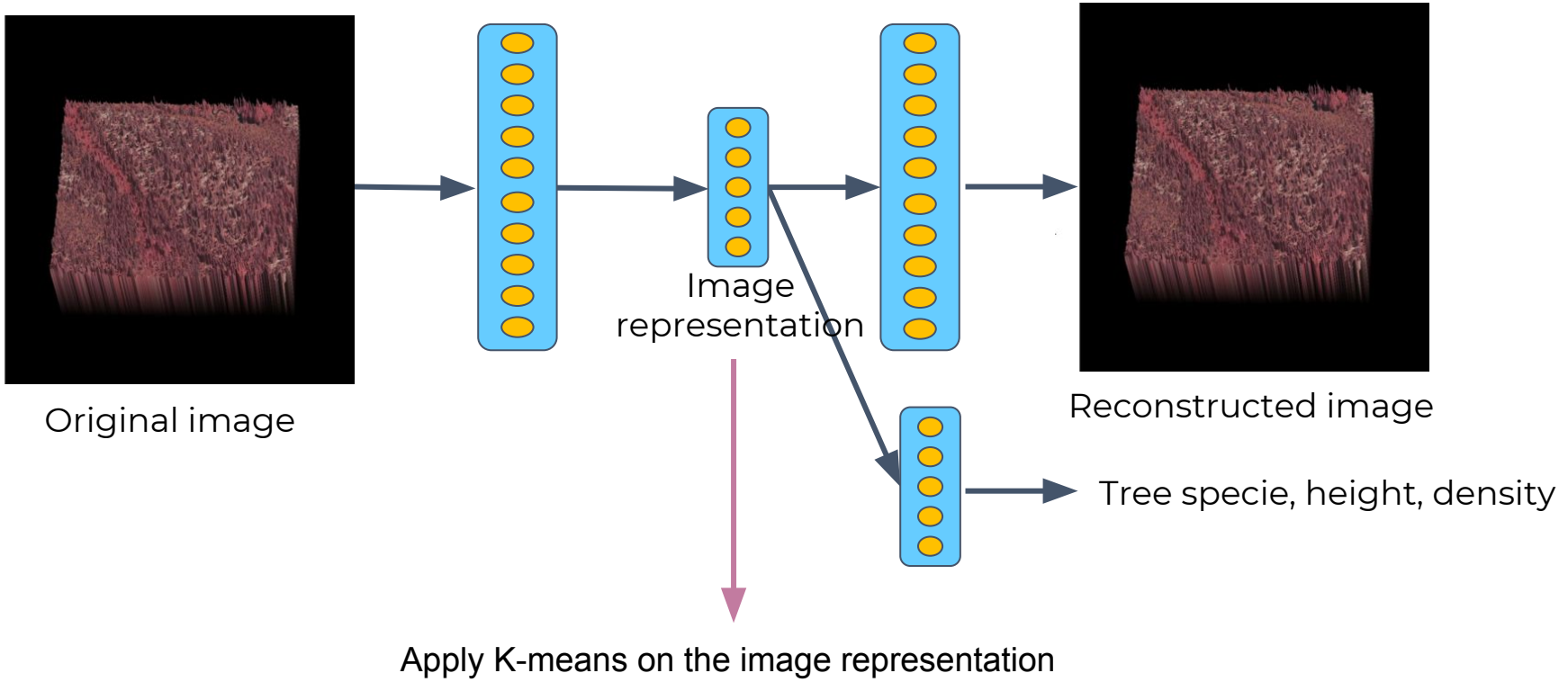


https://mubaris.com/posts/kmeans-clustering/

Unsupervised learning (Block 2)



Semi-supervised learning (Block 3)



Official evaluation metric

- Patch classification accuracy =
  # correctly classified patches / total # patches

- A patch is correctly classified if the predicted tree specie, height and density are all correct.

Informative evaluation metrics

- Tree specie classification accuracy =
  # patches with correct tree specie prediction / total # patches

- Tree height classification accuracy =
  # patches with correct tree height prediction / total # patches

- Tree density classification accuracy =
  # patches with correct tree density prediction / total # patches

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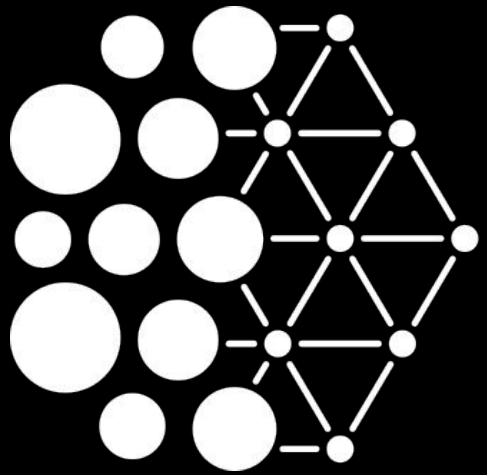

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