Tree Based Representations for Satellite Image Time Series

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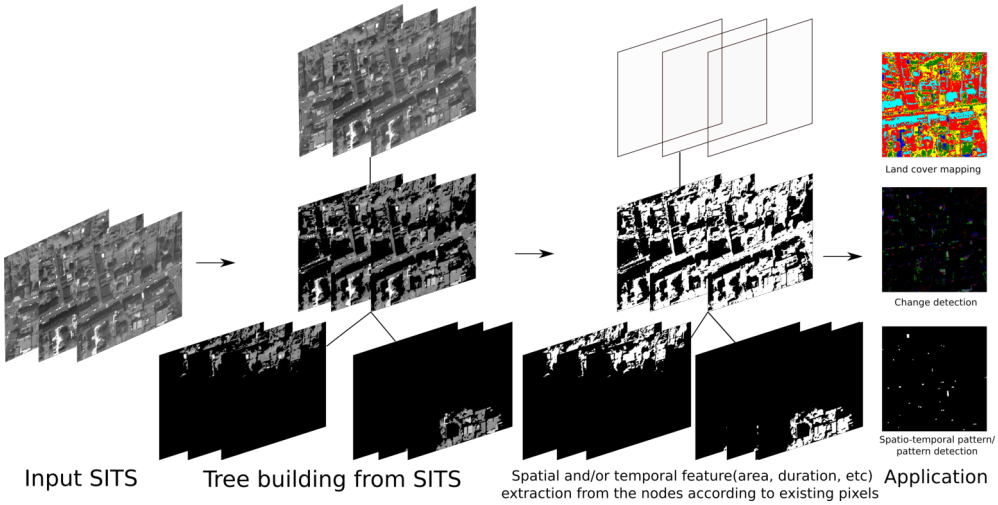
Objectives

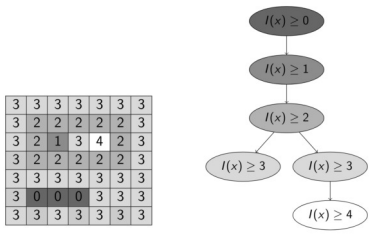
Earth observation (EO) has become one of the important ways to understand our planet and its dynamics with the evolved technology day by day. Satellite images enable us to monitor our planet with this improved technology which provides higher temporal resolution. The aim of this thesis is to show how to adapt the tree-based representations to SITS, and how to apply classification, change detection or spatio-temporal pattern recognition methods to them. Contribution of this thesis will include three steps;

1. Tree building
2. Feature extraction
3. Novel methods for EO applications

Workflow

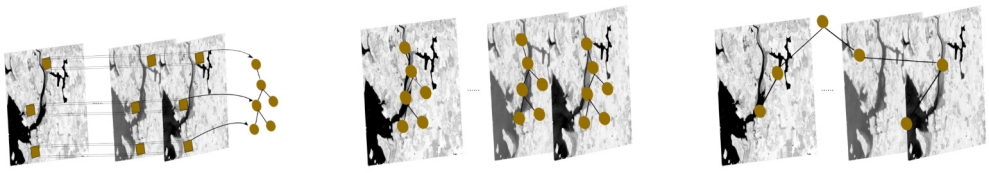


Tree for a Single Image



- There are several tree types such as max-tree, min-tree, tree of shapes, α-tree, binary partition tree, etc.
- Max-tree: $L_\lambda(f) = \{p \in \Omega | f(p) \geq \lambda\}$

Tree building strategies



(a) Spatial hierarchy (b) Temporal hierarchy (c) Spatial-temporal hierarchy

- SH: The series of image frames first mapped into a single, representative image
- TH: Tree building for each frame separately
- STH: Space-time tree building for each set

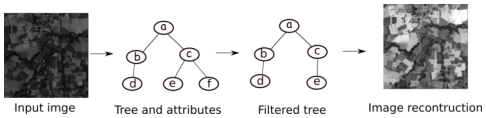
Attributes

Spatial	Temporal
Area	Duration
Height	Starting time
Compactness	End time
Rectangularity	Node centroid
Eccentricity	Variance
Mean Gray value	Temporal stability
Volume	Attribute evolution
Perimeter	Time of Max/Min value

Feature extraction

Filtering

- Filtering consists in pruning the tree according to some node attributes and selected criteria. A filtered image is reconstructed after pruning process.



Pattern spectra

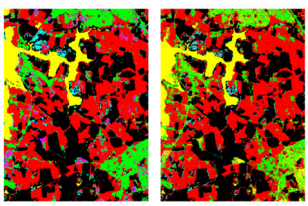
- Pattern spectra is the histogram-like distribution of the node attributes. It can be produced in 1D, 2D or 3D with selected attributes.

Applications

- Land cover mapping
  - Attribute Profiles for SITS [IGARSS 2019]
- Change detection
  - Analysis of Min-Trees for Flood Detection [MULTITEMP 2019]
  - Monitoring Urban growth, [JURSE 2019]
- Spatio-temporal pattern recognition
  - Publication target

Experiments

Land cover mapping
- Attribute profiles
- Feature profiles
- Extinction profiles



Change detection
- Urban monitoring
- Flood detection
- Outlier removal

ST pattern recognition
- Tide observation
- Crop monitoring
- Object detection