Improving knowledge discovery from synthetic aperture radar images using the linked open data cloud and Sextant

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Outline

- Knowledge discovery from EO images in DLR
- The linked open data cloud
- The tool Sextant
- Improving knowledge discovery using Sextant
- Conclusions
Knowledge discovery and semantic annotation in DLR

tiling

TerraSAR-X image

patches

feature extraction

relevance feedback

SVM classifier

semantic labels

class1

... class2

... class3

...
Knowledge discovery and semantic annotation in DLR

The result of the process

Nature

Landcover
- Woods
- Fields
- Sea

Man-made structures
- Buildings
- Ports
- Residential area
## Knowledge discovery and semantic annotation in DLR

<table>
<thead>
<tr>
<th>Type of areas</th>
<th>Scene location</th>
</tr>
</thead>
<tbody>
<tr>
<td>Urban and infrastructure areas</td>
<td>• Africa – 5 scenes</td>
</tr>
<tr>
<td></td>
<td>• Asia – 21 scenes</td>
</tr>
<tr>
<td></td>
<td>• Europe – 48 scenes</td>
</tr>
<tr>
<td></td>
<td>• Middle East – 8 scenes</td>
</tr>
<tr>
<td></td>
<td>• North America – 16 scenes</td>
</tr>
<tr>
<td></td>
<td>• South America – 11 scenes</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>No. of scenes / No. of patches</th>
<th>No. of semantic categories</th>
<th>Methodology</th>
</tr>
</thead>
<tbody>
<tr>
<td>109 scenes 110,000 patches</td>
<td>850 categories</td>
<td>• Support Vector Machine</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• Relevance Feedback</td>
</tr>
</tbody>
</table>

The table shows the number of scenes and patches for different types of areas and the number of semantic categories used. The methodology includes Support Vector Machine and Relevance Feedback.
Data modeling for knowledge discovery and semantic annotation

- Conceptual modeling of the **knowledge discovery process** and the **semantic classes** using an **OWL ontology**.

- Use **geospatial** and **temporal extensions** of the **SPARQL query language** to query such data (e.g., GeoSPARQL and stSPARQL).

**Benefits**

- High expressivity

- Declarative querying (e.g., “find all satellite images with patches containing water limited on the north by a port”)

- Combination with other data sources
  - high-quality GIS data
  - emerging/dynamic web resources and **linked geospatial data**
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The Linked Open Data cloud
CORINE Land Cover (CLC)

Available on datahub as linked data
Urban Atlas (UA)

Available on datahub as linked data
Open Street Map (OSM)
Sextant

A web-based tool for

- **browsing** and **exploring** linked geospatial data
- **creating thematic maps** produced by querying the **spatial** and **temporal** dimensions of **linked data** and other geospatial data sources in **OGC standard file formats** (e.g., KML)
- **sharing** and **collaborative editing** of thematic maps

Find more at: [http://sextant.di.uoa.gr/](http://sextant.di.uoa.gr/)

Interoperable with well-known GIS tools (e.g., ArcGIS, QGIS, Google Earth)
Improving the knowledge discovery process of DLR using Sextant

TerraSAR-X image

tiling

patches

feature extraction

relevance feedback

SVM classifier

semantic classes

class 1

class 2

class 3

...

semantic labels

Nature

Landcover

Man-made structures

Woods

Fields

Sea

Buildings

Ports

Residential area

0 1 5 ... 64 3 17

-4 13 59 ... 4 7 0

1 1 25 ... 0 4 19

3 21 6 ... 5 5 1 8

22 99 5 ... 9 4 0
Improving the knowledge discovery process of DLR using Sextant
SVM–RF: a semi-automatic process

Iterative annotation of TerraSAR-X image patches using the SVM classifier with a relevance feedback module (RF)

Green patches: positive examples

Red patches: negative examples

Blue patches: classified
SVM–RF: a semi-automatic process

Current status of SVM-RF

- Cannot discern the content of a patch
- Difficult to work on radar images only
- Man in the loop

Improvements using Sextant

- Bring in auxiliary geospatial data sources
- Bring in background maps (and any other WMS layer)
- Automate using logical if-then rules
Improving the knowledge discovery process of DLR using Sextant

Validation of patch annotations corresponding to port areas

Improving the knowledge discovery process of DLR using Sextant

Validation of patch annotations corresponding to port areas

Improving the knowledge discovery process of DLR using Sextant

Validation of patch annotations corresponding to buoys
Improving the knowledge discovery process of DLR using Sextant

Validation of patch annotations corresponding to **buoys**

<table>
<thead>
<tr>
<th></th>
<th>Logical if-then rules</th>
</tr>
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<tbody>
<tr>
<td>1</td>
<td>if patch.annotation = &quot;buoy&quot; AND patch.inside(sea) AND</td>
</tr>
<tr>
<td>2</td>
<td>FORALL other_patch.annotation = &quot;water_way&quot;</td>
</tr>
<tr>
<td>3</td>
<td>AND ( NOT patch.near(other_patch) OR patch.intersects(other_patch) )</td>
</tr>
<tr>
<td>4</td>
<td>then</td>
</tr>
<tr>
<td>5</td>
<td>patch.remove_annotation()</td>
</tr>
<tr>
<td>6</td>
<td>fi</td>
</tr>
</tbody>
</table>

**TerraSAR-X**

image

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road network

( OSM )

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**buoys**

(DLR)
Improving the knowledge discovery process of DLR using Sextant

Validation of patch annotations corresponding to buoys

logical if-then rules

1 if patch.annotation = "buoy" AND patch.inside(sea) AND
2 FORALL other_patch.annotation = "water_way"
3 AND ( NOT patch.near(other_patch) OR patch.intersects(other_patch) )
4 then
5 patch.remove_annotation()
6 fi
Improving the knowledge discovery process of DLR using Sextant

Validation of patch annotations corresponding to buoys
Improving the knowledge discovery process of DLR using Sextant

Validation of patch annotations corresponding to buoys
Other applications of Sextant

Rapid mapping

Other applications of Sextant

Evolution of land cover

Other applications of Sextant

Monitoring of fire fronts

Sextant is being extended

- Map registry
- Legend information
- Production of statistical maps
- Development of appropriate interfaces for mobile platforms
- Query builder integration
- Support of more file formats: ESRI shapefiles, JPEG JFIF, FITS, etc.

Tell us about your needs!
Conclusions

- Knowledge discovery and semantic annotation of TerraSAR-X images in DLR
- Linked open data and semantic web technologies can prove useful to (and enhance) EO products

The tool Sextant

User-contributed maps (OSM)

Environmental data (CLC and UA)

Knowledge discovery

- validation
- accuracy
- automation
Thank you
Useful links

- TELEIOS project
  http://earthobservatory.eu/

- Linked EO data
  http://datahub.io/organization/teleios

- Sextant
  http://sextant.di.uoa.gr/

- Strabon
  http://strabon.di.uoa.gr/