Scalable Geospatial Services for Time Series & Value-added Maps in Agriculture and Water Quality Monitoring

A. Karmas & K. Karantzalos
Remote Sensing Lab., National Technical University of Athens, Greece

thanasis.karmas@gmail.com    karank@central.ntua.gr
http://users.ntua.gr/karank/

esa
2016 conference on big data from space research, technology and innovation
European Space Agency
Motivation

Handle and process EO big data from

- Various Sensors (spectral, spatial, temporal resolution)
- Platforms (satellite, airborne, in-situ)

Make EO data a mainstream

- Different kind of users
- Both Experts & End-users

Current Challenges

- Automation
- Exploit multi-modal data for analytics
- Exploit entire archives for analytics
- Validation
Problem to Solve

Expand standard remote sensing approaches e.g.,:

- Classification
- Change Detection

- **Fuse** Data with Time Series analysis
- Formulate more *constrained* problems


Problem to Solve

Expand standard remote sensing approaches

✓ Integrate multi-modal data
✓ Execute various software modules on distributed systems

❖ Robust Analytics

✓ Yu et al., 2016: A new approach for land cover classification and change analysis: Integrating backdating and an object-based method, Remote Sensing of Environment


✓ Zhu and Woodcock, 2014: Continuous change detection and classification of land cover using all available Landsat data, Remote Sensing of Environment
Dominating Architecture

- Repositories
- Cloud-based Infrastructures
  - Databases
  - Processing Models
- Web Services
- Geospatial Maps

Cloud-based Infrastructure e.g., Hadoop

Geospatial Data Processing & Analytics

OGC
- Standards, Interoperability, Services

HPC Computing
- Parallel Programming, Hybrid Architectures

Cloud Computing e.g., MapReduce, Stream Processing

MrGeo

Relational DBMS
- SQL
  - PostGIS, Oracle Spatial

NoSQL Column store
- APIs
  - MonetDB
  - HBase, Oracle GeoRaster

ArrayDBMS
- extended SQL

External DBs & Geospatial Repositories
- Linked & Open Data, Satellite Archives, National Agencies, etc

Front-End, Client
- Geospatial Services, Visual Analytics
Our Approach

✓ EO Datasets
  o Sentinels
  o Landsat
  o RapidEye
  o Pleiades
  o Worldview-2/-3

✓ Databases
  o Rasdaman

✓ Geospatial Services
  o Canopy Greenness
  o Chlorophyll-a Maps
  o Land Cover Mapping
  o Time series

Cloud Computing
  e.g., MapReduce, Stream Processing

HPC Computing
  Parallel Programming, Hybrid Architectures

Cloud-based Infrastructure
  e.g., Hadoop

Geospatial Data Processing & Analytics

OGC Standards, Interoperability, Services

Relational DBMS
  SQL
  PostGIS

ArrayDBMS
  extended SQL
  Rasdaman

External DBs & Geospatial Repositories
  Linked & Open Data, Satellite Archives, National Agencies, etc

Front-End, Client
  Geospatial Services, Visual Analytics
Our Approach

✓ Multi-sensor EO datasets


Our Approach

- Multi-sensor EO datasets

Applications:
- Water Quality Monitoring


Our Approach

✓ Multi-sensor EO datasets

✓ Applications:
  o Precision Agriculture

The computed geospatial maps regarding the estimated Chlorophyll and Maturity levels for **Chardonnay** vineyards

✓ Kandylakis and Karantzalos, 2016. Precision viticulture from multitemporal, multispectral very high resolution satellite data, ISPRS Archives of the Photogrammetry, Remote Sensing and Spatial Information Sciences.

✓ Karantzalos et al., 2015. RemoteAgri: Processing Online Big Earth Observation Data for Precision Agriculture, European Conference on Precision Agriculture, pp.421-428
Our Approach

✓ Online, on the server-side Land Cover Mapping
✓ Automated
✓ at National Scale
✓ at the entire L8 archive

GEOSPATIAL SERVICES
WebClient: GeoExt, OpenLayers, etc

Time Series from Multi-Sensor Archives

- One 4D datacube (i) per sensor, (ii) per path-row/tile
- Specific WCPS queries (process/algorithm/index) per sensor
- Merging multi-sensor intermediate results
- Statistical analysis on derived observations
- Delivering Multi-sensor Time Series

**EO Datasets**
- Sentinels
- Landsat
- RapidEye
- Pleiades
- Worldview-2/-3
Time Series
from multi-sensor data
Time Series
from multi-sensor data

Landsat 8
29 July 2014
Time Series from multi-sensor data

Landsat 8
29 July 2014

RapidEye
17 Aug 2014
Time Series from multi-sensor data

Landsat 8
29 July 2014

RapidEye
17 Aug 2014

Landsat 8
4 Oct 2015

Combined Time Series for NDVI

01 Jun 13  01 Aug 13  01 Oct 13  01 Dec 13  01 Feb 14  01 Apr 14  01 Jun 14  01 Aug 14  01 Oct 14  01 Dec 14  01 Feb 15  01 Apr 15  01 Jun 15  01 Aug 15  01 Oct 15  01 Dec 15  01 Feb 16
Time Series from multi-sensor data

Landsat 8 29 July 2014
RapidEye 17 Aug 2014
Landsat 8 4 Oct 2015
Sentinel-2 26 Dec 2015
Time Series
from multi-sensor data

Worldview-2
1 Aug 2013
Time Series

from multi-sensor data

Pleiades

7 Aug 2014
Time Series
from multi-sensor data

Worldview-2
28 Aug 2015
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Thank You - Gracias