DEVELOPMENT OF AN OPEN SOURCE TOOLBOX FOR THE ANALYSIS AND VISUALIZATION OF REMOTELY SENSED TIME SERIES

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PROBLEM

Long time series of RS data available to study behaviour of dynamic phenomena

Problems if animated with few controls
✓ extraction of subsets
✓ comparisons
✓ change blindness \rightarrow mixture of bottom-up (driven by visual info) and top-down (attention- or task-driven)

Attention: crucial role in change perception, but limited!

http://www.earthobservations.org/geonetcast.shtml
HOW TO REDUCE ...

Our aim is to facilitate top-down processing through effective (bottom-up) visualization:

- by letting ‘figures’ stand out against a ‘ground’
  - tracking of objects $\rightarrow$ polygons
  - classification
  - enabling selection of subsets
  - option to keep the context (‘figure’) around a selection visible, but subdued (‘ground’)

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HOW TO REDUCE ...

✓ enabling selection of subsets
HOW TO REDUCE ...

- by adding other functions
  - multiple layers
  - control of display speed

Implementation:
extension of ILWIS for visual exploration of animated time series
USE OF THE TOOLBOX

Ethiopian lowlands:
✓ serious droughts
✓ flash floods

Explore relations vegetation ↔ precipitation:
✓ Spot-5 VEGETATION: NDVI
✓ MSG: Multi-Sensor Precipitation Estimates

Algorithm detects precipitating features and binds them into objects
✓ polygons
✓ paths

1. Fix feature index \( l \) in previous time step \( i-1 \)
2. For a given feature index \( l \), determine feature index \( k_{\text{MO}} \) in current time step \( i \) with maximum spatial overlap:
   \[
   k_{\text{MO}}(l) = \arg \max \left[ \text{Size}(F_i^{l-1} \cap F_k^i) \right]
   \]
3. For a given feature index \( k_{\text{MO}} \), determine feature index \( l_{\text{MO}} \) in previous time step \( i-1 \) with maximum spatial overlap:
   \[
   l_{\text{MO}}(k_{\text{MO}}) = \arg \max \left[ \text{Size}(F_i^{l-1} \cap F_{k_{\text{MO}}}^i) \right]
   \]
4. Check if feature indices are the same: \( l_{\text{MO}} = l \)
USE OF THE TOOLBOX

Use strategies

overview

zoom / filter

details on demand

analyse first

show important

zoom / filter

analyse further

details on demand

Shneiderman, 1996

Keim et al., 2006

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USE OF THE TOOLBOX
USE OF THE TOOLBOX

Early evaluation of selected visualization functions

Monitoring tasks – NDVI time series of Ethiopia
✓ 8 participants (‘with’) : toolbox with the new functions
✓ 8 participants (‘without’) : toolbox without the new functions

Methods used: think aloud, observation, questionnaires, interview

Effectiveness

Efficiency (av. time / task, minutes)

Satisfaction:
comparable (high) rates, but ‘with’ had more confidence in the tasks
USE OF THE TOOLBOX

Less difference than expected due to bugs / deficiencies

Improvements made in:
- selection of attribute values
- display of variations within selected values
- dynamic link between legend and display area
- speed control and interface

Main rendering: by the graphics hardware (OpenGL)

Potential bottlenecks:
- raster: amount of available graphics RAM
- vector: number of triangles needed to render the polygons
CONCLUSIONS

Single Open Source environment:
✓ access to GEONETCast data
✓ pre-processing
✓ analytical and animation functions

α - version ready
but further work to be done ...
FUTURE

Preprocessing of time series:
✓ projection / resampling of images
✓ filling missing pixels
✓ image smoothing

Analytical / visualization functionality:
✓ tracking algorithms
✓ quantification / visualization of attributes
✓ options to compare / synchronize time series
✓ optimization of the temporal legend

Evaluation: do the tools reduce change blindness !?