OGC Raster Processing Services: Standardization and Implementation

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Sensor, image, and statistics data form an important part of today's geo data mix. Technically, they usually can be represented as multi-dimensional raster data, such as 1-D timeseries, 2-D imagery, 3-D image time series or geophysical data, 4-D climate/ocean data, and n-D statistics data with "abstract", non-spatiotemporal axes. While today's efforts still emphasize mere data availability through open, easy-to-navigate extraction interfaces, the next quality of service foreseeably will include on-demand analysis capabilities.

In the family of open geo standards which the Open GeoSpatial Consortium (OGC, www.opengeospatial.org) develops it is the Web Coverage Service (WCS) which offers raster (ie, "coverage") data access [2]. WCS defines a service interface for data extraction based on spatial and temporal subsetting, range ("band", "channel") subsetting, reprojection, and data format encoding.

This data retrieval service currently is being extended by the Web Coverage Processing Servicw (WCPS) which adds a coverage processing language for flexible ad-hoc navigation, extraction, and analysis [1]. By nesting expressions, tasks of unlimited expressions can be formulated. WCPS, therefore, has already been dubbed "SQL for coverages". The Web Processing Service (WPS) is extended by WCPS with a means to not just invoke static functionality, but also allow run-time request composition by clients.

The following example inspects coverages Modis1, Modis2, and Modis3 in turn, picks those where the average red intensity exceeds 127, and delivers the difference between red and near-infrared (nir) band, encoded in TIFF:

```
for m in ( Modis1, Modis2, Modis3 )
where
        avg( m.red ) > 127
return
        encode( abs( m.red - m.nir ), "TIFF" )
```

The reference implementation of WCPS is based on the rasdaman raster DBMS [3]. WCPS requests are translated into queries of the rasdaman

query language, rasql. Queries are internally optimized and then executed against raster objects stored in a standard relational database, partitioned ("tiled") into Binary Large Objects (BLOBs). Due to the semantics formalization there is a clear, stable interface which allows implementations to perform manifold optimizations and exploit hardware parallelism.

Query optimization is a wide research area and one of our core research domains. Algebraic optimization rewrites queries Q into other queries Q' such that Q and Q' deliver the same result, but Q' faster. Parallel evaluation allows both concurrent database access and performance increases by tasking more than one CPU with answering a query. Additionally, installed graphic cards are engaged in query processing.

A demonstration website, www.earthlook.org, has been established for showcasing the capabilities of WCPS in 1-D to 4-D application scenarios.

In summary, standards-conformant, value-adding geo raster services have become feasible. Currently OGC voting has commenced to adopt the WCPS specification as an official Implementation Standard. Among the next steps are: evaluation of WCPS in as many different earth science application domains as possible; theoretical investigations on raster languages and their expressiveness; further exploiting the optimization potential to fully leverage the potential of this forthcoming raster processing standard.

REFERENCES

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