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Encoding continuous spatial phenomena in GML

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In the discussion about how to model and encode geographic information two meta-models of space exist: the 'object' view and the 'field' view. This difference in conceptual view is also reflected in different data models and encoding formats.
Among GIS practitioners, 'fields' (or 'coverages') are being used almost exclusively in 2D, while in the geoscience community 3D and higher-dimensional fields are widely used. (Note that the dimensions in oceanographic/atmospheric coverages are not necessarily spatial dimensions, as any parameters (e.g. temperature of the air, or density of water) can be considered a dimension.)
While standardisation work in ISO and OGC has led to agreement on how to best encode discrete spatial objects, for the modelling and encoding of continuous 'fields' there are still a number of open issues.

In the presentation we will shortly discuss the current standards related to fields, and look at their shortcomings and potential. In ISO 19123 for example a distinction is made between discrete and continuous coverages, but the difference is not very clear and hard to capture for implementers. As far as encoding is concerned: GML 3.x (ISO 19136) has a discrete coverage data type, but no continuous coverage type.

We will then present an alternative solution to model fields, and show how it can be implemented using some parts of GML, but not the ISO/GML coverage type.
This alternative data model for fields permits us to represent fields in 2D and 3D, although conceptually it can be easily extended to higher dimensions.
Unlike current standards where there is a distinction between discrete and continuous fields/coverages, we argue that a field should always have one - and only one! - value for a given attribute at every location in the spatial domain (be this domain the surface of the Earth, a 3D volume, or even a 4D spatio-temporal hypercube).

The principal idea behind the proposed model is that two things are needed to have a coverage:
1. a set of samples of the phenomenon;
2. an interpolation function to reconstruct the continuity of the phenomenon studied.
The samples can be any data that was collected to study the phenomenon: a set of scattered points in 2D or 3D; a set of lines (e.g. contour lines coming from a topographic map); a raster image coming from remote sensing or photogrammetry where the value of each pixel represents the temperature of the sea for instance; a triangulated irregular network or its counterpart in 3D; etc. For the interpolation function one must think of the usual interpolation methods (Piecewise, IDW, Kriging, NearestNeighbour, RST, GridInterpolation (Bilinear, Trilinear) etc.), but the list can easily be extended.

The proposed conceptual model has the following advantages:
- it respects the scientific definition of a field;
- it is simple from a theoretical point of view, and thus easy to understand for users. A field is always something continuous; if you only have a dataset of scattered points, this is not a field.
- it permits us to model every situation (and that in 2D and in 3D). Thus, no sub-types are necessary.
- it uses types already defined in current implementation standards (i.e. GML).
- it is extensible. Users can "plug" their own interpolation methods.
- more importantly, it is more adapted than raster structures to the kind of datasets found in GIS related applications, because it permits us to always keep the original data that were collected to study a phenomenon, and

simply generate new representations that are adapted to a particular use and application.
- it is implementable. As a proof of concept a GML application schema was created, and some datasets were made as examples. We have called this prototype encoding language FieldGML, because as much as possible existing elements from the GML specification have been used (but not the coverage type itself).

At the workshop we will go deeper into the 'why' and 'how' of the proposed conceptual model for fields, look at the implementation with parts of GML, and discuss how our approach fits in the broader picture: the relation with CSML, ncML-GML and WCS (response to a GetCoverage request), and - at the conceptual model side - the Common Data Model (Unidata, GALEON).