FieldML: *a standard for modelling and interchanging field descriptions*

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Motivation for FieldML

- Support more complex field representations than possible with existing formats and software.
- Describe field functions explicitly using the most basic, irreducible objects and mathematical operators.
- Modular and extensible.
- Still efficiently support today's common field representations.

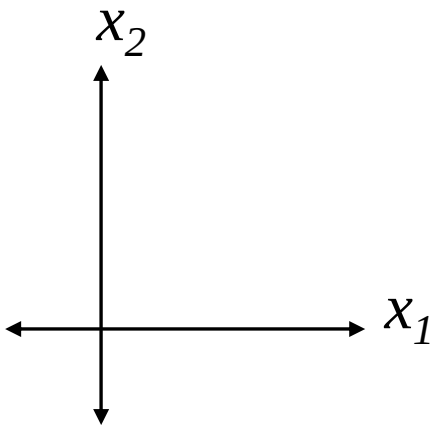
Generalised Fields

Field is “a set of related values defined over some domain” where:

- any values are possible (commonly real-valued scalar, vector, matrix etc. but also integer, string, object, and structures of these);
- the domain itself consists of one or more primitive field types which declare continuous spaces, discrete entities or some combination (e.g. a mesh).

“Everything is a field” (almost)

Example: Basis Functions

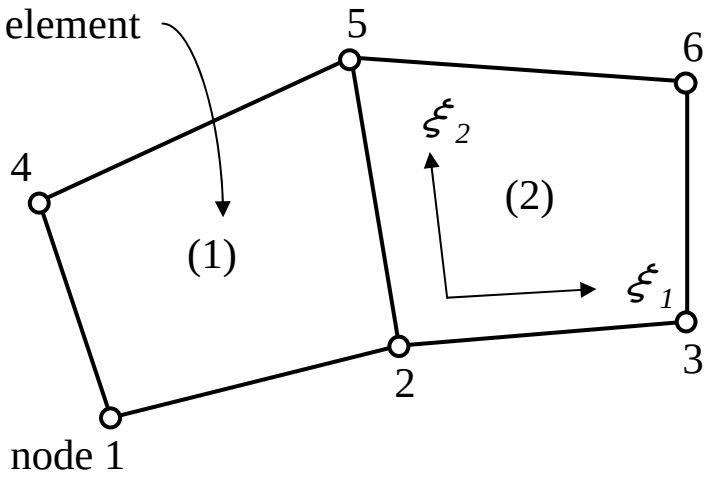


$$\phi_1 = (1 - x_1)(1 - x_2)$$
$$\phi_2 = x_1(1 - x_2)$$
$$\phi_3 = (1 - x_1)x_2$$
$$\phi_4 = x_1 x_2$$

"domain" field $\boldsymbol{x}$

"evaluated" field $\boldsymbol{\phi(x)}$

Example: Interpolated Field



$$y = y_p^e \cdot \phi\left(\xi^e\right)$$

$$y_p^e = \left[y^n\left(n_1^e\right) \quad y^n\left(n_2^e\right) \quad y^n\left(n_3^e\right) \quad y^n\left(n_4^e\right)\right]$$

$$n^e = \begin{cases} element1 \rightarrow 1 & 2 & 4 & 5 \\ element2 \rightarrow 2 & 3 & 5 & 6 \end{cases}$$

$$y_p^n = \begin{cases} node1 \rightarrow 0.0 & 0.0 \\ node2 \rightarrow 1.1 & 0.3 \\ \cdots \end{cases}$$

Other Fields

- Images
- Time sequences (signals)
- Arrays

- Anything where:

Field value = *f* (source field values)

Field Type

- Basic domains including coordinate systems and discrete ensembles (sets of objects)
- Field operators including mathematical functions (add, subtract, sin, cos, gradient, piecewise…), lookup functions, parameter maps… acting on other fields.

Fields also have attributes including units, can be embedding in other field spaces.

Use metadata to communicate deeper purpose.

FieldML Models

Container of:

- Fields owned by model
- Sub-models

Provide:

- Namespace and scope
- Hierarchies – consistent with existing applications.

Development Efforts

Open Source Software largely built on FieldML concepts:

- Cmgui – modelling and visualisation
  www.cmiss.org/cmgui
- OpenCMISS – large scale computation
  www.opencmiss.org

Serialisation formats:

- Work in progress
- XML, eventually binary (e.g. HDF5)

Thank You

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FieldML website www.fieldml.org

Any Questions?