Computational Physiology DSLs – LibCellML and related ideas

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Background

The ABI Software Laboratory contributes to a number of open source software projects that are focussed on the computational modelling needs of bioengineering, computational physiology, and related fields.

- **Model representation** – CellML, FieldML[1]
- **Repository**
  - Models – PMR
  - Data – PMR, CAP
- **Simulation** – OpenCMISS-Iron
- **Visualisation** –OpenCMISS-Zinc, Cmgui
- **Workflow**: MAP Client
- **Tools**: CAP Client, OpenCOR

Challenges

Multiphysics, multiscale, population variation, agent based modelling.
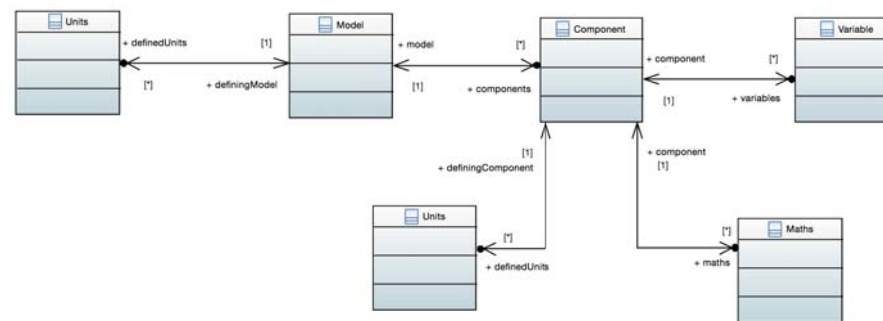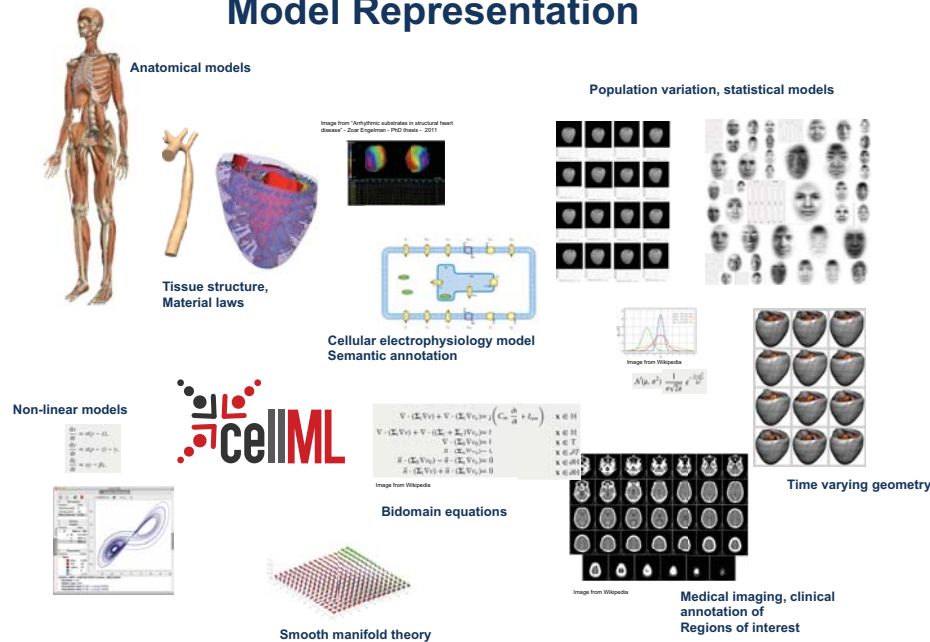
Computational demands

Research reproducibility

Model repurposing

Approaches

- **System Modularity** - separation of concerns:
  - Solver vs. model: Domain Specific Language (DSL) for model, e.g. CellML, FieldML, SBML
  - Modularity within model – e.g. separate CellML components.

Model Representation

Anatomical models

Tissue structure, Material laws

Non-linear models

Smooth manifold theory

Bidomain equations

Cellular electrophysiology model Semantic annotation

Population variation, statistical models

Time varying geometry

Medical imaging, clinical annotation of Regions of interest

LibCellML Domain Specific Object model

Related work

CellML API
- Library for processing CellML v1.0 and v1.1 models.
- Used by: OpenCOR, OpenCell, PMR, OpenCMISS-Iron, Antimony

FieldML
- Similar goals, but focussed on time varying spatial models (geometry and advanced fields)

Prototypes
- Haskell: DSLs, EDSLs (embedded DSLs) and model processing.

Recent work

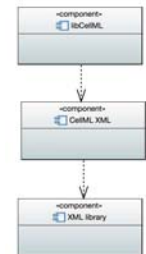**LibCellML**: Library for processing CellML models.

Just started.

Planned support for CellML version 1.2 (still WIP)

C++11 codebase

Open source, on GitHub[2]

XML bindings (probably Generated using *Code Synthesis XSD*[3])

References

1. Britten, R.D., et al., *FieldML, a proposed open standard for the Physiome project for mathematical model representation.* Medical & biological engineering & computing, 2013. **51**(11): p. 1191-1207.
2. https://github.com/cellml/libcellml/
3. http://www.codesynthesis.com/products/xsd/