Maiprogs Fact Sheet

Design goals

- Broad class of algorithms with FEM and/or BEM
- Support theoretical analysed algorithms with numerical examples
- Develop new schemes and algorithms numerically

The Maiprogs Framework

- All methods integrated in a common system with standardized and flexible interfaces
- Allows casual users to work in a more abstract way
- Simplifies version control, avoids repeated implementations
- Offers large collection of source code as reference
- Common data format allows pre- and post-processing without knowledge of internal data structures

Software development

- Modularity allows students to re-use large part of the frame work
- Only truly new code has to be implemented
- Well-tested code simplifies debugging considerably
- Interfaces are standardized and documented
- Globally available data structures
- Standard libraries for computation of Galerkin elements in 2d/3d BEM allows accelerated development

Problems

- Polygonal and polyhedral boundaries
- Smooth general boundaries
- BEM for PDE's with constant coefficients
- Laplace-, Lamé-, Helmholtz-, Stokes-, biharmonic and transport problems in 2d and 3d
- Dirichlet-, Neumann-, mixed boundary value problems
- First kind, second kind integral equations
- Galerkin and collocation methods
- Elasto-Plastic problems
- Time-dependent problems, e.g. heat- and wave-equation
- Contact problems with FEM and BEM

Transmission/Coupling formulations

- Symmetric Galerkin-FEM-BEM coupling
- Dual-Dual FEM-BEM coupling
- Least-Squares FEM-BEM coupling

and their variants with variable coefficients or nonlinear variants

Meshes

General hp-mesh data structure with arbitrary mesh elements and arbitrary polynomial order

- quasi-uniform h-version
- p-version
- algebraically graded h-version
- hp-version with geometrical mesh refinement
- adaptively refined meshes
- general unstructured meshes

Adaptivity

- Free configurable and extendable error indicator toolbox
- Residual based
- Gradient based
- Hierarchical decomposition based

Solvers

- CG, GMRES, MINRES, CGNE, BiCGStab
- BPX
- Multigrid
- Domain decomposition (2-level)
- Hhp-3-level decompositions

High-Performance Computing

- quadruple and multi-precision arithmetic
- OpenGL interface for graphics
- Fully parallelized with OpenMP
- Fully parallelized with MPI for clusters

Under development

- CUDA interface for Graphic-Card Computing
- Automatic code-generation for Bilinear forms on high-performance architectures

Maiprogs hard facts:

- 20+ years development time
- 290000+ lines of Fortran 95 code
- Documentation available:
  `http://people.brunel.ac.uk/~mastmmm`
  `http://people.brunel.ac.uk/~mastmmm/bone.pdf`