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ogs6 – a new concept for porous-fractured media simulations

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OpenGeoSys (OGS) is a scientific open-source initiative for numerical simulation of thermo-hydro-mechanical/chemical (THMC) processes in porous and fractured media, continuously developed since the mid-eighties. The basic concept is to provide a flexible numerical framework for solving coupled multi-field problems. OGS is targeting mainly on applications in environmental geoscience, e.g. in the fields of contaminant hydrology, water resources management, waste deposits, or geothermal energy systems, but it has also been successfully applied to new topics in energy storage recently. OGS is actively participating several international benchmarking initiatives, e.g. DECOVALEX (waste management), CO_2BENCH (CO_2 storage and sequestration), SeSBENCH (reactive transport processes) and HM-Intercomp (coupled hydrosystems).

Despite the broad applicability of OGS in geo-, hydro- and energy-sciences, several shortcomings became obvious concerning the computational efficiency as well as the code structure became too sophisticated for further efficient development. OGS-5 was designed for object-oriented FEM applications. However, in many multi-field problems a certain flexibility of tailored numerical schemes is essential. Therefore, a new concept was designed to overcome existing bottlenecks. The paradigms for ogs6 are:
- Flexibility of numerical schemes (FEM#FVM#FDM),
- Computational efficiency (PetaScale ready),
- Developer- and user-friendly.

ogs6 has a module-oriented architecture based on thematic libraries (e.g. MeshLib, NumLib) on the large scale and uses object-oriented approach for the small scale interfaces. Usage of a linear algebra library (Eigen3) for the mathematical operations together with the ISO C++11 standard increases the expressiveness of the code and makes it more developer-friendly. The new C++ standard also makes the template meta-programming technique code used for compile-time optimizations more compact.

We have transitioned the main code development to the GitHub code hosting system (https://github.com/ufz/ogs). The very flexible revision control system Git in combination with issue tracking, developer feedback and the code review options improve the code quality and the development process in general. The continuous testing procedure of the benchmarks as it was established for OGS-5 is maintained. Additionally unit testing, which is automatically triggered by any code changes, is executed by two continuous integration frameworks (Jenkins CI, Travis CI) which build and test the code on different operating systems (Windows, Linux, Mac OS), in multiple configurations and with different compilers (GCC, Clang, Visual Studio). To improve the testing possibilities further, XML based file input formats are introduced helping with automatic validation of the user contributed benchmarks.

The first ogs6 prototype version 6.0.1 has been implemented for solving generic elliptic problems. Next steps are envisaged to transient, non-linear and coupled problems.

Literature:
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[2] Naumov D (2015): Computational Fluid Dynamics in Unconsolidated Sediments: Model Generation and Discrete Flow Simulations, PhD thesis, Technische Universität Dresden.