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The Reduced Basis Method in Space and Time: Challenges, Limits and Perspectives — Part 2

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In many engineering applications, a partial differential equation (PDE) has to be solved very often ("multi-query") and/or extremely fast ("realtime") and/or using restricted memory/CPU ("cold computing"). Moreover, the mathematical modeling yields complex systems in the sense that:
(i) each simulation is extremely costly, its CPU time may be in the order of several weeks;
(ii) we are confronted with evolutionary, time-dependent processes with long time horizons or time-periodic behaviors (which often requires long-time horizons in order to
find the time-periodic solution). All problems rely on time-dependent parameterized partial differential equations (PPDEs);
(iii) the processes often involve transport and wave-type phenomena as well as complex coupling and nonlinearities.

Without significant model reduction, one will not be able to tackle such problems. Moreover, there is a requirement in each of the above problems to ensure that the reduced simulations are certified in the sense that a reduced output comes along with a computable indicator which is a sharp upper bound of the error.

The Reduced Basis Method (RBM) is a well-established method for Model Order Reduction of PPDEs. We recall the classical framework for well-posed linear problems and extend this setting towards time-dependent problems of heat, transport, wave and Schrödinger type. The question of optimal approximation rates is discussed and possible benefits of ultraweak variational space-time methods are described.

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