TECHNISCHE UNIVERSITÄT DRESDEN

tu-dresden.de/mathematik

Wintersemester 2023/24

Dresdner Mathematisches Seminar

Prof. Dr. Martin J. Gander

Université de Genève, Section de Mathématiques

Time Parallel Time Integration: Can one predict the far and near future simultaneously?

Predicting the future is already a difficult task, with which we are confronted constantly in everyday life. Will it be raining tomorrow? How will my stock perform? Should I get vaccinated? How will my talk go?

In computational science, one often has a model that can be used for predicting the future, and if the model is accurate, this can work rather well. A good example is weekly modern weather prediction that has become quite accurate. To compute such predictions however, it is common belief that one has to go step by step: one cannot predict the weather for Friday, before (the prediction for) the weather on Thursday is known, since the weather on Friday depends on the weather on Thursday. This is the well-known causality principle for initial value problems: the future is determined by the past, and not the other way round.

When such predictions are calculated, the calculation must terminate before the event happens in the future, otherwise it is not a prediction any more, and Richardson, the first scientist who tried to compute weather predictions (and failed miserably) had already the dream that: "Perhaps someday in the dim future it will be possible to advance the computations faster than the weather advances and at a cost less than the saving to mankind due to the information gained. But that is a dream (1922)".

Time parallel time integration is a recent research field that precisely focuses on algorithms and techniques to compute such predictions parallel in time, i.e. these methods compute simultaneously the near and far future using many processors to do so.

I will explain in my presentation why, in spite of the causality principle, this is well possible for parabolic problems, but much harder for hyperbolic problems. I will then introduce the audience to the four main classes of such time parallel methods, and explain one specific method in each in detail: multiple shooting type methods for initial value problems leading to the Parareal algorithm, waveform relaxation methods based on domain decomposition leading to Schwarz waveform relaxation, multigrid methods leading to a highly scalable space-time multigrid (STMG) method, and also direct space-time parallel methods including ParaExp and ParaDiag. With some of these methods one can even parallelize hyperbolic problems in the time direction, which is very difficult in general.

Mittwoch, 01.11.2023, 17:00 Uhr – Willers-Bau, Raum C 129

Leitung: Prof. Dr. Oliver Sander

Vor dem Vortrag findet **ab 16:30 Uhr** ein gemeinsames **Kaffee-/Teetrinken** vor Hörsaal **WIL C 307 (!)** statt.

Bereich Mathematik und Naturwissenschaften

Fakultät Mathematik