GACR project 2020-22, first meeting

February 11, 2020

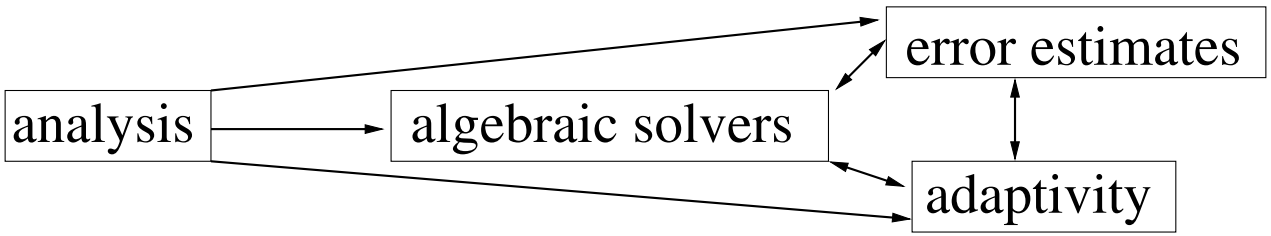
Introduction

Project title

Adaptive methods for the numerical solution of partial differential equations: analysis, error estimates and iterative solvers

Main goal

Reliable and efficient numerical solution for PDEs (including eigenvalue problems)



Our aims

- not only publish quality papers, but try to fulfil the main goal
- communications & meetings necessary

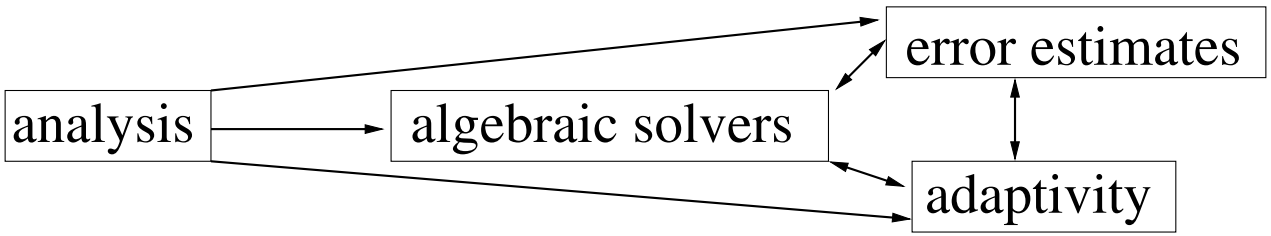
Introduction

Project title

Adaptive methods for the numerical solution of partial differential equations: analysis, error estimates and iterative solvers

Main goal

Reliable and efficient numerical solution for PDEs (including eigenvalue problems)



Our aims

- not only publish quality papers, but try to fulfil the main goal
- communications & meetings necessary

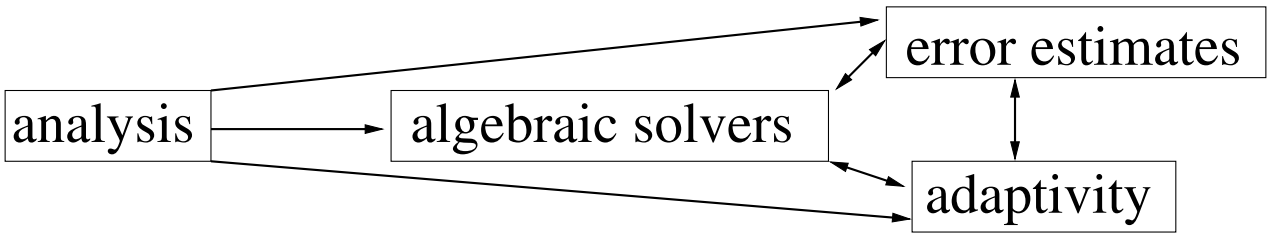
Introduction

Project title

Adaptive methods for the numerical solution of partial differential equations: analysis, error estimates and iterative solvers

Main goal

Reliable and efficient numerical solution for PDEs (including eigenvalue problems)



Our aims

- not only publish quality papers, but try to fulfil the main goal
- communications & meetings necessary

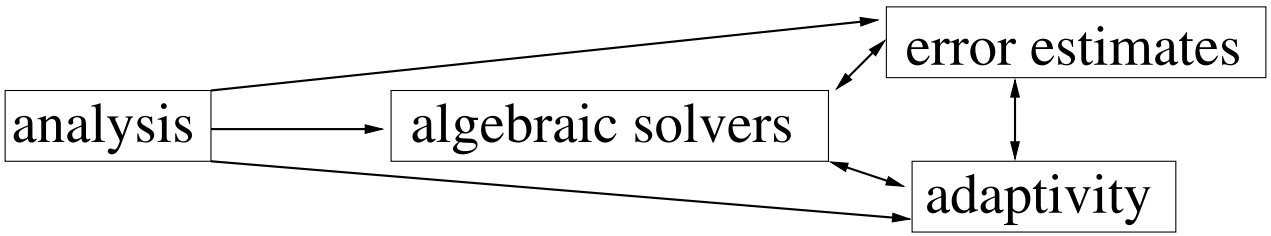
Introduction

Project title

Adaptive methods for the numerical solution of partial differential equations: analysis, error estimates and iterative solvers

Main goal

Reliable and efficient numerical solution for PDEs (including eigenvalue problems)



Our aims

- not only publish quality papers, but try to fulfil the main goal
- communications & meetings necessary

Goals of project meetings

First meeting

- presentation of research plans and interest of team members
- finding possible colaborators (different forms of colaboration)
- 10 minutes presentations

Progress meetings

- 1-2 per year
- information about the progress
- possible coordination of the work

Goals of project meetings

First meeting

- presentation of research plans and interest of team members
- finding possible colaborators (different forms of colaboration)
- 10 minutes presentations

Progress meetings

- 1-2 per year
- information about the progress
- possible coordination of the work

Goals of project meetings

First meeting

- presentation of research plans and interest of team members
- finding possible colaborators (different forms of colaboration)
- 10 minutes presentations

Progress meetings

- 1-2 per year
- information about the progress
- possible coordination of the work

Team members

- **FMP CUNI**

Vít Dolejší

Miloslav Feistauer

Petr Knobloch

Petr Tichý

Václav Kučera

~~Miloslav Vlasák~~

Scott Congreve

Filip Roskovec

Lukáš Vacek

Ondřej Bartoš

- **IM CAS**

Tomáš Vejchodský

Michal Křížek

Miroslav Rozložník

Jakub Šístek

Pavel Kůs

Bangwei She

Jan Papež

Project overview

$$\partial_t \theta(w) + \nabla \cdot f(w) - \nabla \cdot (K(w, \nabla w)\nabla w) + S(w) = g, \quad (1)$$

$$\text{Find } \lambda \in \mathbb{C} \text{ and } u \neq 0 : \quad \mathscr{L} u = \lambda u. \quad (2)$$

WP1 *time-independent problems:* analysis and error estimates of problem (1) with $\partial_t \theta(w) = 0$,

WP2 *time-dependent problems:* analysis and error estimates of problem (1) with $\partial_t \theta(w) \neq 0$,

WP3 *eigenvalue problems:* error estimates for problem (2) for a linear and symmetric operator $\mathscr{L}$,

WP4 *solution strategies:* including algebraic iterative solvers and adaptive methods.

Work Package 1 (WP1): Time-independent problems

- **Task 1.1**: *Analysis of nonlinear elliptic problems* (M. Feistauer, M. Křížek, M. Vlasák, S. Congreve)
- **Task 1.2**: *Goal-oriented error estimates including algebraic errors* (V. Dolejší, P. Tichý, J. Papež, O. Bartoš)
- **Task 1.3**: *Goal-oriented error estimates including mesh anisotropy* (V. Dolejší, F. Roskovec, M. Křížek)
- **Task 1.4**: *Error estimation for convection–diffusion problems* (P. Knobloch, T. Vejchodský, B. She)

Work Package 2 (WP2): Time-dependent problems

- **Task 2.1**: *Nonlinear parabolic problems with singular solutions* (M. Feistauer, M. Vlasák, S. Congreve)
- **Task 2.2**: *Nonlinear reaction-diffusion problems* (M. Feistauer, M. Vlasák, B. She)
- **Task 2.3**: *Coupled nonlinear hyperbolic conservation laws* (V. Kučera, L. Vacek)
- **Task 2.4**: *Nonlinear convection-diffusion-reaction problems* (V. Kučera, L. Vacek, P. Knobloch)
- **Task 2.5**: *Analysis of degenerate parabolic problems* (V. Dolejší, M. Vlasák, S. Congreve, O. Bartoš, student 1)
- **Task 2.6**: *Error estimates for degenerate parabolic problems* (V. Dolejší, S. Congreve, F. Roskovec, student 1)

Work Package 3 (WP3): Eigenvalue problems

- **Task 3.1**: *Guaranteed error bounds for eigenfunctions* (T. Vejchodský, P. Tichý, J. Papež)
- **Task 3.2**: *Lower bounds on eigenvalues by DGM* (T. Vejchodský, V. Dolejší, J. Papež)
- **Task 3.3**: *Adaptivity for eigenvalue problems* (T. Vejchodský, P. Kůs, J. Šístek, M. Křížek)

Work Package 4 (WP4): Solution strategies

- **Task 4.1**: *Anisotropic mesh adaptation* (V. Dolejší, S. Congreve, O. Bartoš, F. Roskovec, student 1)
- **Task 4.2**: *Algebraic solvers for anisotropic meshes* (M. Rozložník, P. Tichý, J. Papež)
- **Task 4.3**: *Algebraic error estimation* (P. Tichý, M. Rozložník, J. Papež)
- **Task 4.4**: *Numerical behaviour of (inexact) iterative methods* (M. Rozložník, P. Tichý, J. Papež)
- **Task 4.5**: *Domain decomposition methods for adaptively refined meshes* (J. Šístek, P. Kůs)
- **Task 4.6**: *Synergy and assessment of the results* (all team members)