

PyPinT

Towards a framework for rapid prototyping of iterative parallel-in-time algorithms

May 28, 2014 | Dieter Moser, Torbjörn Klatt, Dr. Robert Speck <{d.moser,t.klatt,r.speck}@fz-juelich.de> | 3rd Workshop on Parallel-in-Time Integration Methods

Overview

- 1 Recap of existing Parallel-in-Time Algorithms
- 2 The *PyPinT* Framework Explained
- 3 Goals
- 4 Proof of Concept — Examples Analyzed



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Part I: Existing Parallel-in-Time Approaches

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Parareal

RIDC

PFASST



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Part II: The PyPinT Framework Explained

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Basic Concept

- *Python ≥3.2* as language of choice
 - for ease of use and extensibility (cf. *NumPy*, *SciPy*)
- well-conceived and intuitive abstract interfaces
 - for reusable code ensuring DRY principle
- modular building blocks
 - for fast exchange of algorithms' building blocks
- integrated analyzation tools
 - for introspection and plotting (cf. *matplotlib*)
- usage of a sophisticated testing framework
 - nobody writes bug-free code



Modules

Abstract Modelling of PinT Algorithms

pypint

- ~.problems
- ~.solvers
- ~.integrators
- ~.communicators
- ~.multi_level_providers
- ~.solutions
- ~.plugins

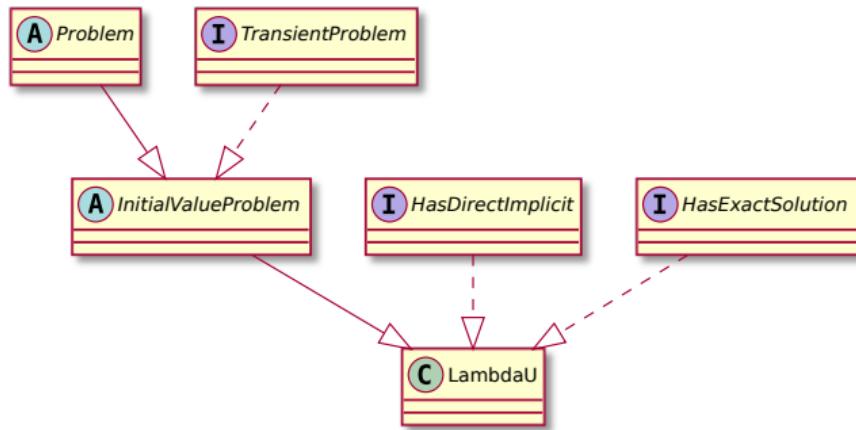


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- interfaces for problem setups
- generic problem with specializations via mixins



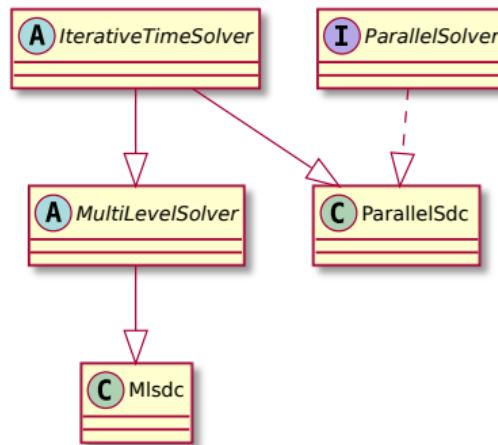
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- interfaces for iterative time solvers
- providing generic building blocks of solvers



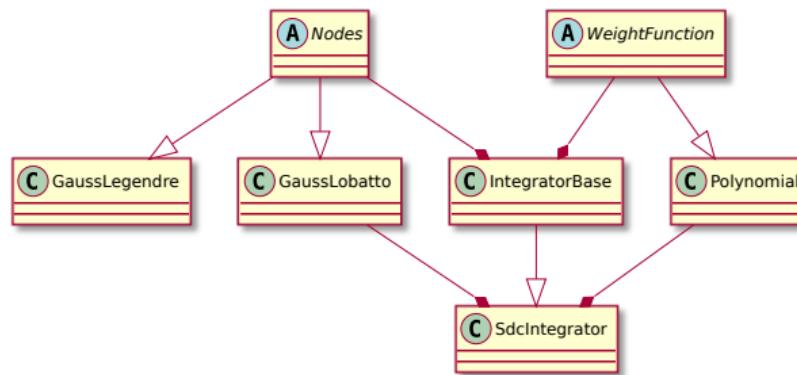
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- providers of various quadrature nodes and weight functions
e.g. Gauss-Lobatto, Gauss-Legendre, polynomial, etc.
- providers aggregated in integrators
for intuitive `.integrate(data, from_node=0, to_node='last')` method



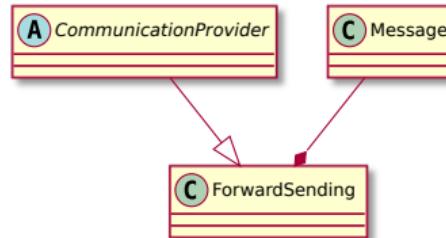
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- generic abstract interfaces for communication patterns e.g. implemented as *forward sending*, etc.
- extendable basic message buffer holding data, solver flags and other meta information



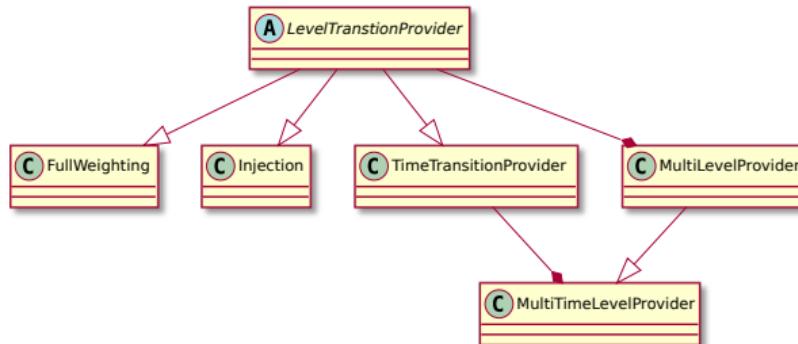
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- abstract interface for generic level transitions
e.g. *full weighting, injection, Legendre-polynomial integration* etc.
- containers for multiple levels
providing access to integrators of each level
- unified generic interface for transitions between levels
via methods `.restringate(data, fine_id, coarse_id)` and
`.prolongate(data, coarse_id, fine_id)`



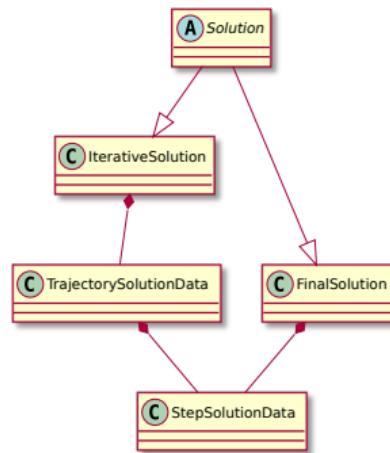
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- containers for solution data + meta information
 - e.g. time-node/step-wise, trajectory (consecutive time nodes)
- container interface for complete solutions
 - e.g. only last time node of last iteration or all nodes of all iterations



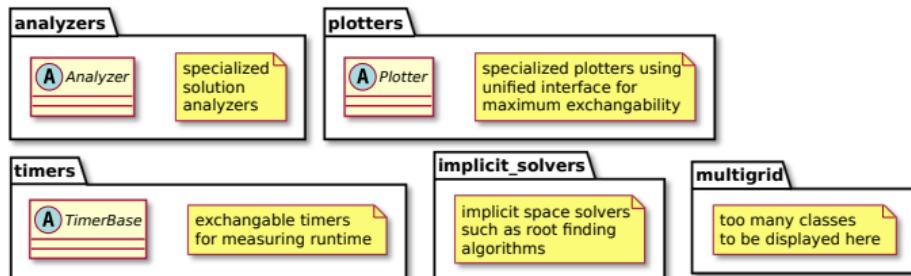
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Part III: Goals for PyPinT

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⇒ suited for educational use
- open-source hosted on  GitHub
⇒ reaching young & rising developers and scientists promoting PINT algorithms



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Part IV: Proof of Concept

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Thank you for your attention!

Questions?

(now or later)

PyPinT is on  GitHub: <https://github.com/Parallel-in-Time/PyPinT>

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