



Discretization Capability Area

Overview

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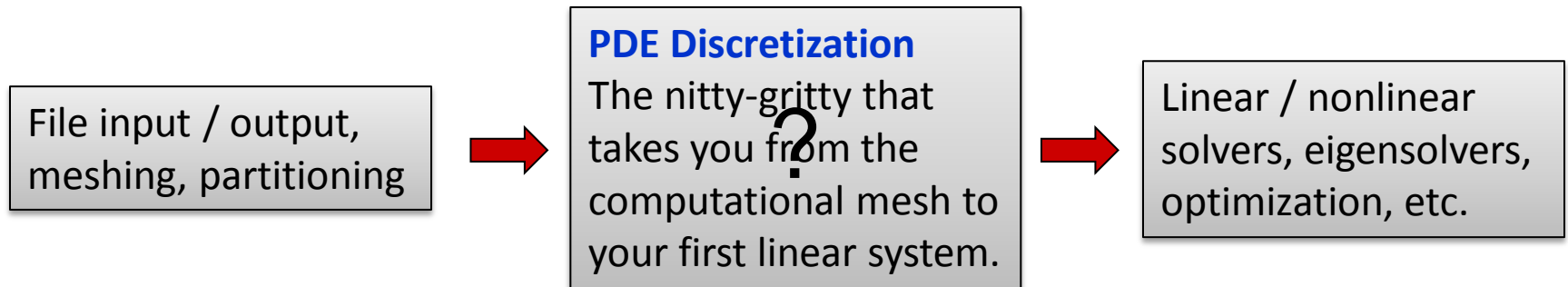
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Discretization Capability Area

What is it?

The Discretization Capability Area is a collection of **low-level software tools** that enable rapid development of application codes based on the numerical solution of partial differential equations (PDEs).





Discretization Capability Area

Which packages?

Shards

definition of cell topology

Intrepid

local (cell-based) FE/FV/FD basis definition; numerical integration; cell geometry; etc.

Phalanx

decomposition of complex PDE systems into a number of elementary user-defined expressions; efficient management of expression dependencies; hooks to embedded tools, etc.

FEI, Panzer

user-defined assignment and management of global degrees of freedom; assembly of local PDE discretization data into distributed linear systems; etc.



Discretization Capability Area

Which packages?

Shards

- a suite of common tools for topological data that facilitate interoperability between PDE software
- cell definitions (e.g., triangle, hexahedron, etc.)
- methods to manage and access information about cell topologies:
 - (1) query adjacencies of subcells
 - (2) find subcell permutation w. r. to global cell
 - (3) create user-defined custom cell topologies

Shards

cell topology

Intrepid

local PDE discretization

Phalanx

PDE expression trees

FEI, Panzer

global DOFs; linear systems

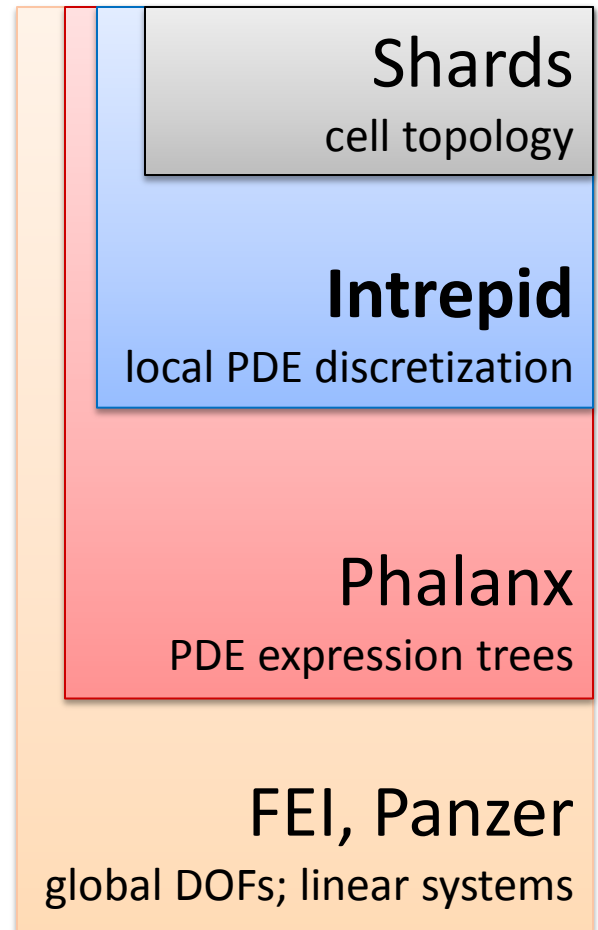


Discretization Capability Area

Which packages?

Intrepid

- physics-compatible cell-local PDE discretizations
- streamlined access to finite element, finite volume and finite difference methods
- support for a wide range of cell topologies
- compatible finite element spaces of arbitrary degree for $H(grad)$, $H(curl)$, $H(div)$ and $L2$ spaces
- Lagrange-interpolating and modal FE bases
- prototype for polyhedral FE bases
- prototype for control-volume (CV) FEM
- numerical integration: spatial and stochastic
- cell geometry tools: volumes, normals, tangents, reference-to-physical maps



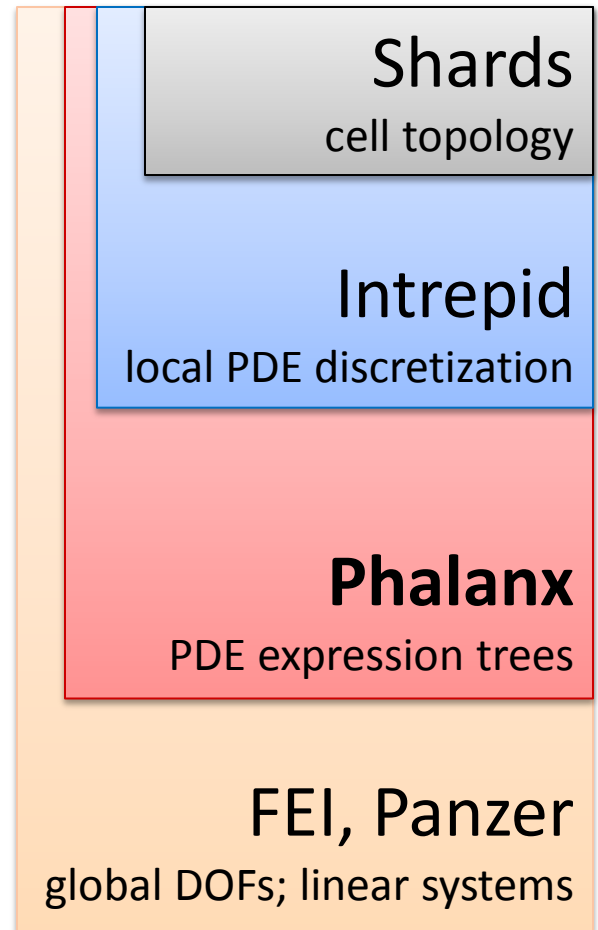


Discretization Capability Area

Which packages?

Phalanx

- cell-local field (variable, data) evaluation kernel specifically designed for general PDE solvers
- decomposition of complex PDE systems into a number of elementary user-defined expressions
- management of expression dependencies
- enables rapid development of large PDE codes
- user-defined data types and evaluation types offer unprecedented flexibility for direct integration with user applications
- they also enable embedded technology such as automatic differentiation for sensitivity analysis, optimization and uncertainty quantification



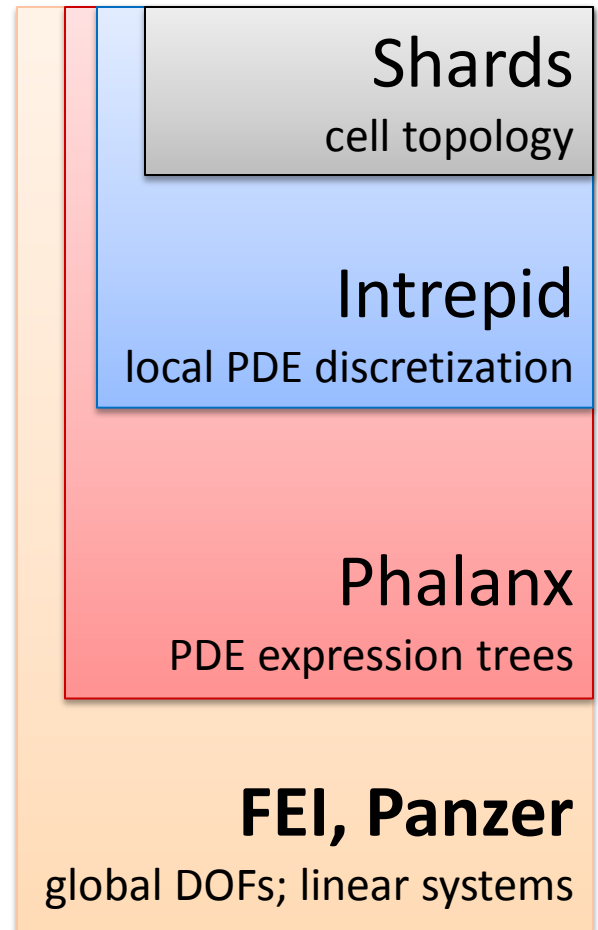


Discretization Capability Area

Which packages?

FEI, Panzer

- user-defined assignment and management of global degrees of freedom (DOFs)
- assembly of cell-local PDE discretization data into global, distributed linear systems
- insulate PDE application codes from linear-algebra issues such as sparse matrix storage and mappings of DOFs to distributed linear equations
- support multi-physics problems, allowing for arbitrarily complicated PDE discretizations with multiple DOFs per subcell (edge-based, face-based, node-based and mixed)





Discretization Capability Area News

- Drekar (used in CASL) represents a superb demonstration of all tools in the Discretization Capability Area: talk to R. Pawlowski and E. Cyr
- Panzer is now officially available in Trilinos (still experimental – patience, please)

Two related presentations today:

- 3:45pm - 4:15pm, **E. Cyr**: ***A New Degree-of-Freedom Capability***
- 4:15pm – 4:30pm, **S. Gao**: ***Discretization Tool Use in Charon***