PROGRAMMING ABSTRACTIONS FOR AFDM

- GRID
  ⇒ defines the structure of the discretization
- GRID_FUNCTION
  ⇒ defines components of the PDEs on the GRID
- DOMAIN
  ⇒ GRID + GRID_FUNCTION(s) + IntegrationScheme

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GRID

Attributes

- Geometry: connectivity, grid spacing, extent, . . .
- Boundary: external/internal boundary specifications
- Coordinates: coordinate system associated with grid points
- Refinement: specifies the type of refinement and the grid hierarchy

Operations

- Alias <region >
- Load/Store <region >
- Refine/Coarsen <region >
- View <region >
- Query Operators
- Indexing Operators (Fortran 90)
  $\Rightarrow$ space-time dimensions; grid hierarchy

For Parallelism

- Decomposition Scheme

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Views of a GRID

The GRID class provides 2 view of the grid hierarchy:

- Hierarchical View (Dynamic DAG of Grids)
  - ⇒ Each grid can be individually indexed and operated on
  - ⇒ Used for:
    - - defining integration operators on a grid
    - - defining inter-grid operations
- Composite View
  - ⇒ Single composite grid
  - ⇒ Refinement information stored locally
  - ⇒ Used for:
    - - generation of composite partitioning
    - - defining recursive operations on the grid hierarchy

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GRID_FUNCTION

Attributes

- Name
  (Fortran 90 array identifier when assigned to a GRID)
- Type
- Dimension
- Boundary Condition
- Initialization
- Interior/Boundary Integration Function
- Prolongation Function
- Restriction Function

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GRID_FUNCTION (Contd)

Operations

- Initialize
- SetBoundaryCondition
- Integrate $<$level $>$
- Prolong/Restrict $<$level1,level2 $>$
- View/Store

DOMAIN Class

Components

- GRID
- GRID_FUNCTION(s)
- Operators of the form:

$$U(GRID\_FUNCTION(s)) \Rightarrow GRID\_FUNCTION(s)$$

- GRID_FUNCTION integration sequence
- Integration ordering along grid hierarchy
  $\Rightarrow$ e.g. Berger/Oliger integration scheme
- Residuals
- Local error estimation & regriding criterion
- Miscellaneous parameters
  $\Rightarrow$ e.g. buffer size, regrid frequency

DOMAIN Class (Contd)

Operations

- Initialize
- SetBoundaryCondition
- Evolve
- ErrorEstimate
- Regrid
- ComputeResiduals
- View/Store <GRID_FUNCTION(s),level >

An AFDM Program

(1) Define GRID
(2) Define GRID_FUNCTION(s)
(3) Define DOMAIN
(4) Define Auxiliary Parameters

(5) Initialize DOMAIN
(6) SetBoundaryCondition DOMAIN
(7) Repeat *nstep*
  $\rightarrow$ Evolve DOMAIN
  $\rightarrow$ ComputeResiduals DOMAIN
  $\rightarrow$ Conditional View/Store

(8) Output