
MSLib – The MultiScale Library

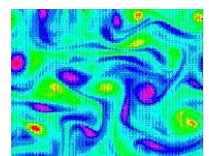
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Wavelets and Multiscale Methods in Numerical Analysis and Simulation

What is the MSLib?

- a research code!
- not a user-friendly direct to use platform!
- a C++ library containing functions to support wavelet based methods for solving operator equations
- runs on many platforms and compilers
- public domain
- always under construction and extension
- a base tool for further development
 - wavelets on domains (U.; Vorloeper)
 - adaptive wavelet methods (Barinka, Barsch, Charton, Cohen, Dahlke, Dahmen, U.)
 - wavelet methods for Stokes- and Navier-Stokes equations (U.; Barsch)
 - evaluation of nonlinear functionals (Barinka, Dahmen, Schneider, Xu)
 - wavelet methods in turbulence (Albukrek, U.)
 - ...
- features templates and inheritance

MatLib

- Arrays
- Vectors
- Matrices
 - Sparse matrices
 - Symmetric sparse matrices
 - Block banded matrices
- Solvers
 - direct and iterative solvers for linear systems
 - * QR
 - * LU
 - * Pseudo inverse
 - * cg, preconditioned cg
 - * gmres
 - * bicgstab
 - direct and iterative solvers for eigenvector problems
 - * (inverse) power iteration
 - * condition number
 - * SVD
 - iterative solvers for saddle-point problems
 - * Uzawa (different variants)
 - interfaces to LAPACK routines
- Preconditioners
 - Multilevel
 - BPX (MLLib)
- interface to Matlab

Inheritance in MatLib

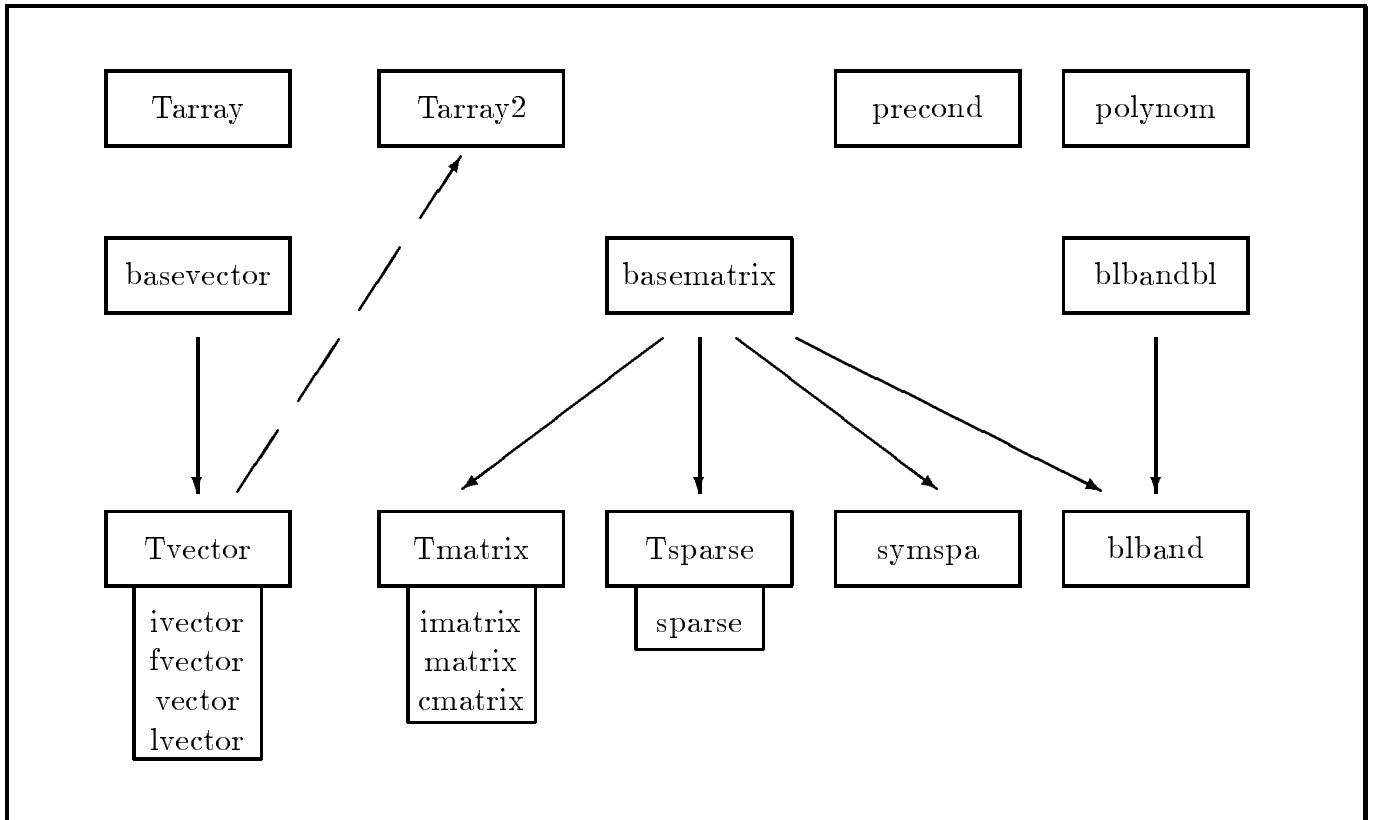


Figure 1: Inheritance of the classes in MatLib. Some members of the class Tarray2 use objects of type Tvector as in- and output.

- abstract base classes as kernels
- inheritance of common properties
- templates allow *scalable* data structures

MLLib

- multilevel algorithms on the whole euclidean space
- independent on the space dimension
- refinable functions and wavelets
- collection of filters
 - Daubechies
 - biorthogonal B-spline wavelets
 - box splines
- point evaluation
- multilevel transformations
- computation of refinable integrals
- setup of stiffness matrices
- modifications for divergence-free wavelets
- interfaces to TecPlot and Matlab

Inheritance in MLLib

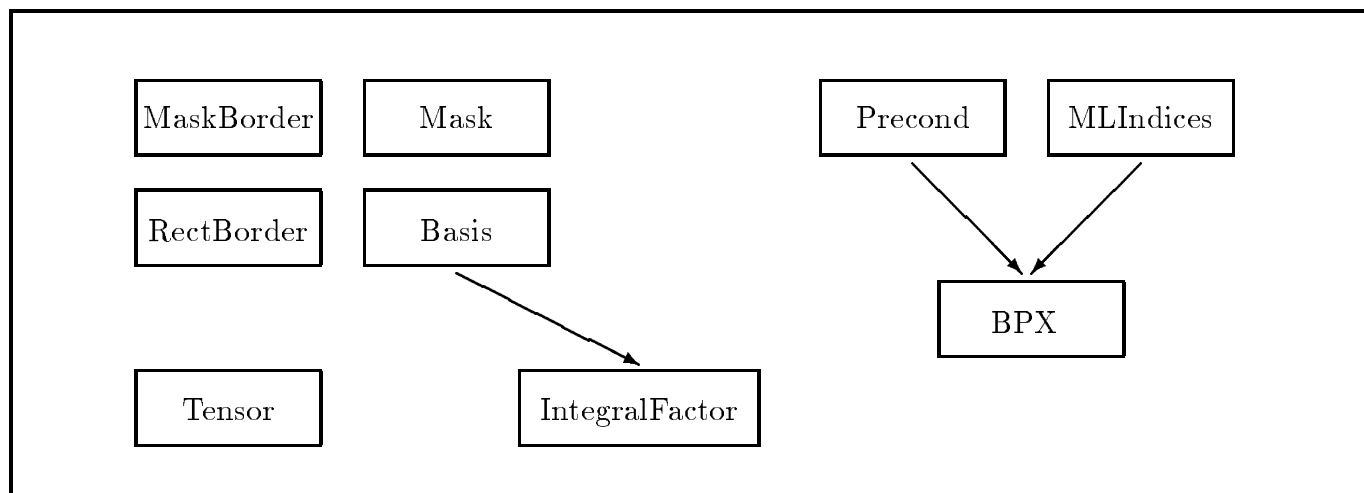


Figure 2: Classes in MLLib

- `MaskBorder` contains the borders for the dynamical allocation
- `Mask` contains the mask coefficients
- `Basis` is a collection of masks
- `IntegralFactor` is the input for refinable integrals

Intervall

- biorthogonal B-spline wavelets on the intervall á la
 - Dahmen, Kunoth, Urban
 - Dahmen, Schneider
 - Canuto, Tabacco, Urban
- different biorthogonalization techniques
 - standard monomials
 - SVD
 - Bernstein polynomials
 - ...
- point evaluation
- integrals of scaling functions and wavelets
- interfaces to TecPlot and Matlab

Structure of Intervall

I–Mask

- masks of $\varphi, \tilde{\varphi}$ on \mathbb{R}
- D_L, \tilde{D}_L :

$$\varphi_{j,k} = \sum_m (D_L)_{m,k} \varphi_{[j,m]} |_{\mathbb{R}^+}$$



I–Basis

- computation of scaling functions and wavelets
- multiscale transformation matrices (blocks)
- coarsest level
- reconstruction, decomposition
- change of bases
- point evaluation

I–Integrals

- refinable integrals
- integrals wavelet/wavelet, wavelet/arb. function

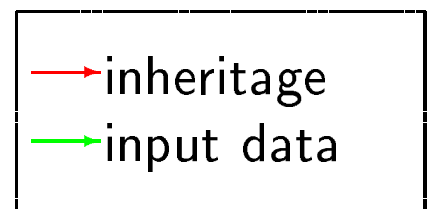
I–MaskB spline

- moments of $\varphi, \tilde{\varphi}$
- gramian $\langle \Phi_j^L, \tilde{\Phi}_j^L \rangle$
- method of biorthogonalization
- optimization of condition number
- boundary conditions



I–BasisB spline

- overall setup
- primal/dual system
- particular constr.



Outlook

- new components will be added
- main purpose: research
- interpolatory wavelets
- European summer school Valencia, 3.-14.7.2000

Further Information

- IGPM homepage
- TMR software database
- documentation (MatLib, MLLib) on the net
- papers: Barsch, U.; Barsch, Kunoth, U.
- available under the gnu license by sending a mail plus password
- more than 120 times distributed