Octave C++ Classes

Edition 1.0 for Octave version 7.3.0

The Octave Project Developers

This is the first edition of the documentation for Octave's C++ classes, and is consistent with version 7.3.0 of Octave.

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1 Acknowledgements

Contributors to Octave

In addition to John W. Eaton, several people have written parts of liboctave. (This has been removed because it is the same as what is in the Octave manual.)

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Version 3, 29 June 2007

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2 A Brief Introduction to Octave

This manual documents how to run, install and port Octave's C++ classes, and how to report bugs.

3 Arrays

3.1 Constructors and Assignment

`Array<T>` (*void*) [Constructor]
Create an array with no elements.

`Array<T>` (*int* `n` [, *const T &*`val`]) [Constructor]
Create an array with *n* elements. If the optional argument *val* is supplied, the elements are initialized to *val*; otherwise, they are left uninitialized. If *n* is less than zero, the current error handler is invoked (see Chapter 13 [Error Handling], page 47).

`Array<T>` (*const Array<T> &*`a`) [Constructor]
Create a copy of the *Array<T>* object *a*. Memory for the *Array<T>* class is managed using a reference counting scheme, so the cost of this operation is independent of the size of the array.

`Array<T>& operator =` (*const Array<T> &*`a`) [Assignment on `Array<T>`]
Assignment operator. Memory for the *Array<T>* class is managed using a reference counting scheme, so the cost of this operation is independent of the size of the array.

`int capacity` (*void*) *const* [Method on `Array<T>`]
`int length` (*void*) *const* [Method on `Array<T>`]
Return the length of the array.

`T& elem` (*int* `n`) [Method on `Array<T>`]
`T& checkelem` (*int* `n`) [Method on `Array<T>`]
If *n* is within the bounds of the array, return a reference to the element indexed by *n*; otherwise, the current error handler is invoked (see Chapter 13 [Error Handling], page 47).

`T& operator ()` (*int* `n`) [Indexing on `Array<T>`]

`T elem` (*int* `n`) *const* [Method on `Array<T>`]
`T checkelem` (*int* `n`) *const* [Method on `Array<T>`]
If *n* is within the bounds of the array, return the value indexed by *n*; otherwise, call the current error handler. See Chapter 13 [Error Handling], page 47.

`T operator ()` (*int* `n`) *const* [Indexing on `Array<T>`]

`T& xelem` (*int* `n`) [Method on `Array<T>`]
`T xelem` (*int* `n`) *const* [Method on `Array<T>`]
Return a reference to, or the value of, the element indexed by *n*. These methods never perform bounds checking.

`void resize` (*int* `n` [, *const T &*`val`]) [Method on `Array<T>`]
Change the size of the array to be *n* elements. All elements are unchanged, except that if *n* is greater than the current size and the optional argument *val* is provided,

the additional elements are initialized to *val*; otherwise, any additional elements are left uninitialized. In the current implementation, if *n* is less than the current size, the length is updated but no memory is released.

`const T* data` (*void*) *const* [Method on `Array<T>`]

`Array2<T>` *Array2<T> Array2* (*void*) [Constructor]
`Array2<T>` (*int* `n`, *int* `m`) [Constructor]
`Array2<T>` (*int* `n`, *int* `m`, *const T* &`val`) [Constructor]
`Array2<T>` (*const Array2<T>* &`a`) [Constructor]
`Array2<T>` (*const DiagArray<T>* &`a`) [Constructor]

`Array2<T>& operator =` (*const Array2<T>* &`a`) [Assignment on `Array2<T>`]

`int dim1` (*void*) *const* [Method on `Array2<T>`]
`int rows` (*void*) *const* [Method on `Array2<T>`]

`int dim2` (*void*) *const* [Method on `Array2<T>`]
`int cols` (*void*) *const* [Method on `Array2<T>`]
`int columns` (*void*) *const* [Method on `Array2<T>`]

`T& elem` (*int* `i`, *int* `j`) [Method on `Array2<T>`]
`T& checkelem` (*int* `i`, *int* `j`) [Method on `Array2<T>`]

`T& operator ()` (*int* `i`, *int* `j`) [Indexing on `Array2<T>`]

`void resize` (*int* `n`, *int* `m`) [Method on `Array2<T>`]
`void resize` (*int* `n`, *int* `m`, *const T* &`val`) [Method on `Array2<T>`]

`Array3<T>` (*void*) [Constructor]
`Array3<T>` (*int* `n`, *int* `m`, *int* `k`) [Constructor]
`Array3<T>` (*int* `n`, *int* `m`, *int* `k`, *const T* &`val`) [Constructor]
`Array3<T>` (*const Array3<T>* &`a`) [Constructor]

`Array3<T>& operator =` (*const Array3<T>* &`a`) [Assignment on `Array3<T>`]

`int dim1` (*void*) *const* [Method on `Array3<T>`]
`int dim2` (*void*) *const* [Method on `Array3<T>`]
`int dim3` (*void*) *const* [Method on `Array3<T>`]

`T& elem` (*int* `i`, *int* `j`, *int* `k`) [Method on `Array3<T>`]
`T& checkelem` (*int* `i`, *int* `j`, *int* `k`) [Method on `Array3<T>`]

`T& operator ()` (*int* `i`, *int* `j`, *int* `k`) [Indexing on `Array3<T>`]

`void resize` (*int* `n`, *int* `m`, *int* `k`) [Method on `Array3<T>`]
`void resize` (*int* `n`, *int* `m`, *int* `k`, *const T* &`val`) [Method on `Array3<T>`]

`DiagArray<T>` (*void*) [Constructor]
`DiagArray<T>` (*int* `n`) [Constructor]
`DiagArray<T>` (*int* `n`, *const T* &`val`) [Constructor]
`DiagArray<T>` (*int* `r`, *int* `c`) [Constructor]
`DiagArray<T>` (*int* `r`, *int* `c`, *const T* &`val`) [Constructor]
`DiagArray<T>` (*const Array<T>* &`a`) [Constructor]
`DiagArray<T>` (*const DiagArray<T>* &`a`) [Constructor]

`operator =` (*const DiagArray<T>* &`a`) [Assignment on `DiagArray<T>&`]

`int dim1` (*void*) *const* [Method on `DiagArray<T>`]
`int rows` (*void*) *const* [Method on `DiagArray<T>`]

`int dim2` (*void*) *const* [Method on `DiagArray<T>`]
`int cols` (*void*) *const* [Method on `DiagArray<T>`]
`int columns` (*void*) *const* [Method on `DiagArray<T>`]

`T& elem` (*int* `r`, *int* `c`) [Method on `DiagArray<T>`]
`T& checkelem` (*int* `r`, *int* `c`) [Method on `DiagArray<T>`]

`T& operator ()` (*int* `r`, *int* `c`) [Indexing on `DiagArray<T>`]

`void resize` (*int* `n`, *int* `m`) [Method on `DiagArray<T>`]
`void resize` (*int* `n`, *int* `m`, *const T &val*) [Method on `DiagArray<T>`]

The real and complex `ColumnVector` and `RowVector` classes all have the following functions. These will eventually be part of an `MArray<T>` class, derived from the `Array<T>` class. Then the `ColumnVector` and `RowVector` classes will be derived from the `MArray<T>` class.

Element by element vector by scalar ops.

`RowVector operator +` (*const RowVector &*`a`, *const double &*`s`)
`RowVector operator -` (*const RowVector &*`a`, *const double &*`s`)
`RowVector operator *` (*const RowVector &*`a`, *const double &*`s`)
`RowVector operator /` (*const RowVector &*`a`, *const double &*`s`)

Element by element scalar by vector ops.

`RowVector operator +` (*const double &*`s`, *const RowVector &*`a`)
`RowVector operator -` (*const double &*`s`, *const RowVector &*`a`)
`RowVector operator *` (*const double &*`s`, *const RowVector &*`a`)
`RowVector operator /` (*const double &*`s`, *const RowVector &*`a`)

Element by element vector by vector ops.

`RowVector operator +` (*const RowVector &*`a`, *const RowVector &*`b`)
`RowVector operator -` (*const RowVector &*`a`, *const RowVector &*`b`)

`RowVector product` (*const RowVector &*`a`, *const RowVector &*`b`)
`RowVector quotient` (*const RowVector &*`a`, *const RowVector &*`b`)

Unary MArray ops.

`RowVector operator -` (*const RowVector &*`a`)

The `Matrix` classes share the following functions. These will eventually be part of an `MArray2<T>` class, derived from the `Array2<T>` class. Then the `Matrix` class will be derived from the `MArray<T>` class.

Element by element matrix by scalar ops.

`Matrix operator +` (*const Matrix &*`a`, *const double &*`s`)
`Matrix operator -` (*const Matrix &*`a`, *const double &*`s`)
`Matrix operator *` (*const Matrix &*`a`, *const double &*`s`)
`Matrix operator /` (*const Matrix &*`a`, *const double &*`s`)

Element by element scalar by matrix ops.

`Matrix operator +` (*const double &s, const Matrix &a*)
`Matrix operator -` (*const double &s, const Matrix &a*)
`Matrix operator *` (*const double &s, const Matrix &a*)
`Matrix operator /` (*const double &s, const Matrix &a*)
Element by element matrix by matrix ops.

`Matrix operator +` (*const Matrix &a, const Matrix &b*)
`Matrix operator -` (*const Matrix &a, const Matrix &b*)

`Matrix product` (*const Matrix &a, const Matrix &b*)
`Matrix quotient` (*const Matrix &a, const Matrix &b*)
Unary matrix ops.

`Matrix operator -` (*const Matrix &a*)
The `DiagMatrix` classes share the following functions. These will eventually be part of an `MDiagArray<T>` class, derived from the `DiagArray<T>` class. Then the `DiagMatrix` class will be derived from the `MDiagArray<T>` class.

Element by element MDiagArray by scalar ops.

`DiagMatrix operator *` (*const DiagMatrix &a, const double &s*)
`DiagMatrix operator /` (*const DiagMatrix &a, const double &s*)
Element by element scalar by MDiagArray ops.

`DiagMatrix operator *` (*const double &s, const DiagMatrix &a*)
Element by element MDiagArray by MDiagArray ops.

`DiagMatrix operator +` (*const DiagMatrix &a, const DiagMatrix &b*)
`DiagMatrix operator -` (*const DiagMatrix &a, const DiagMatrix &b*)

`DiagMatrix product` (*const DiagMatrix &a, const DiagMatrix &b*)

Unary MDiagArray ops.

`DiagMatrix operator -` (*const DiagMatrix &a*)

4 Matrix and Vector Operations

`Matrix` (*void*)
`Matrix` (*int* `r`, *int* `c`)
`Matrix` (*int* `r`, *int* `c`, *double* `val`)
`Matrix` (*const Array2*<*double*> &`a`)
`Matrix` (*const Matrix* &`a`)
`Matrix` (*const DiagArray*<*double*> &`a`)
`Matrix` (*const DiagMatrix* &`a`)

`Matrix& operator =` (*const Matrix* &`a`)

`int operator ==` (*const Matrix* &`a`) *const*
`int operator !=` (*const Matrix* &`a`) *const*

`Matrix& insert` (*const Matrix* &`a`, *int* `r`, *int* `c`)
`Matrix& insert` (*const RowVector* &`a`, *int* `r`, *int* `c`)
`Matrix& insert` (*const ColumnVector* &`a`, *int* `r`, *int* `c`)
`Matrix& insert` (*const DiagMatrix* &`a`, *int* `r`, *int* `c`)

`Matrix& fill` (*double* `val`)
`Matrix& fill` (*double* `val`, *int r1*, *int c1*, *int r2*, *int c2*)

`Matrix append` (*const Matrix* &`a`) *const*
`Matrix append` (*const RowVector* &`a`) *const*
`Matrix append` (*const ColumnVector* &`a`) *const*
`Matrix append` (*const DiagMatrix* &`a`) *const*

`Matrix stack` (*const Matrix* &`a`) *const*
`Matrix stack` (*const RowVector* &`a`) *const*
`Matrix stack` (*const ColumnVector* &`a`) *const*
`Matrix stack` (*const DiagMatrix* &`a`) *const*

`Matrix transpose` (*void*) *const*

`Matrix extract` (*int r1*, *int c1*, *int r2*, *int c2*) *const*

`RowVector row` (*int* `i`) *const*
`RowVector row` (*char* **s*) *const*

`ColumnVector column` (*int* `i`) *const*
`ColumnVector column` (*char* **s*) *const*

`Matrix inverse` (*void*) *const*
`Matrix inverse` (*int* &`info`) *const*
`Matrix inverse` (*int* &`info`, *double* &`rcond`) *const*

`ComplexMatrix fourier` (*void*) *const*
`ComplexMatrix ifourier` (*void*) *const*

`DET determinant` (*void*) *const*
`DET determinant` (*int* &`info`) *const*
`DET determinant` (*int* &`info`, *double* &`rcond`) *const*

`Matrix solve` (*const Matrix* &`b`) *const*

`Matrix solve` (*const Matrix &b, int &info*) *const*
`Matrix solve` (*const Matrix &b, int &info, double &rcond*) *const*

`ComplexMatrix solve` (*const ComplexMatrix &b*) *const*
`ComplexMatrix solve` (*const ComplexMatrix &b, int &info*) *const*
`ComplexMatrix solve` (*const ComplexMatrix &b, int &info, double &rcond*) *const*

`ColumnVector solve` (*const ColumnVector &b*) *const*
`ColumnVector solve` (*const ColumnVector &b, int &info*) *const*
`ColumnVector solve` (*const ColumnVector &b, int &info, double &rcond*) *const*

`ComplexColumnVector solve` (*const ComplexColumnVector &b*) *const*
`ComplexColumnVector solve` (*const ComplexColumnVector &b, int &info*) *const*
`ComplexColumnVector solve` (*const ComplexColumnVector &b, int &info, double &rcond*) *const*

`Matrix lssolve` (*const Matrix &b*) *const*
`Matrix lssolve` (*const Matrix &b, int &info*) *const*
`Matrix lssolve` (*const Matrix &b, int &info, int &rank*) *const*

`ComplexMatrix lssolve` (*const ComplexMatrix &b*) *const*
`ComplexMatrix lssolve` (*const ComplexMatrix &b, int &info*) *const*
`ComplexMatrix lssolve` (*const ComplexMatrix &b, int &info, int &rank*) *const*

`ColumnVector lssolve` (*const ColumnVector &b*) *const*
`ColumnVector lssolve` (*const ColumnVector &b, int &info*) *const*
`ColumnVector lssolve` (*const ColumnVector &b, int &info, int &rank*) *const*

`ComplexColumnVector lssolve` (*const ComplexColumnVector &b*) *const*
`ComplexColumnVector lssolve` (*const ComplexColumnVector &b, int &info*) *const*
`ComplexColumnVector lssolve` (*const ComplexColumnVector &b, int &info, int &rank*) *const*

`Matrix& operator +=` (*const Matrix &a*)
`Matrix& operator -=` (*const Matrix &a*)

`Matrix& operator +=` (*const DiagMatrix &a*)
`Matrix& operator -=` (*const DiagMatrix &a*)

`Matrix operator !` (*void*) *const*

`ComplexMatrix operator +` (*const Matrix &a, const Complex &s*)
`ComplexMatrix operator -` (*const Matrix &a, const Complex &s*)
`ComplexMatrix operator *` (*const Matrix &a, const Complex &s*)
`ComplexMatrix operator /` (*const Matrix &a, const Complex &s*)

`ComplexMatrix operator +` (*const Complex &s, const Matrix &a*)
`ComplexMatrix operator -` (*const Complex &s, const Matrix &a*)
`ComplexMatrix operator *` (*const Complex &s, const Matrix &a*)

`ComplexMatrix operator /` (*const Complex &*`s`, *const Matrix &*`a`)

`ColumnVector operator *` (*const Matrix &*`a`, *const ColumnVector &*`b`)
`ComplexColumnVector operator *` (*const Matrix &*`a`, *const ComplexColumnVector &*`b`)

`Matrix operator +` (*const Matrix &*`a`, *const DiagMatrix &*`b`)
`Matrix operator -` (*const Matrix &*`a`, *const DiagMatrix &*`b`)
`Matrix operator *` (*const Matrix &*`a`, *const DiagMatrix &*`b`)

`ComplexMatrix operator +` (*const Matrix &*`a`, *const ComplexDiagMatrix &*`b`)
`ComplexMatrix operator -` (*const Matrix &*`a`, *const ComplexDiagMatrix &*`b`)
`ComplexMatrix operator *` (*const Matrix &*`a`, *const ComplexDiagMatrix &*`b`)

`Matrix operator *` (*const Matrix &*`a`, *const Matrix &*`b`)
`ComplexMatrix operator *` (*const Matrix &*`a`, *const ComplexMatrix &*`b`)

`ComplexMatrix operator +` (*const Matrix &*`a`, *const ComplexMatrix &*`b`)
`ComplexMatrix operator -` (*const Matrix &*`a`, *const ComplexMatrix &*`b`)

`ComplexMatrix product` (*const Matrix &*`a`, *const ComplexMatrix &*`b`)
`ComplexMatrix quotient` (*const Matrix &*`a`, *const ComplexMatrix &*`b`)

`Matrix map` (*d_d_Mapper* `f`, *const Matrix &*`a`)
`void map` (*d_d_Mapper* `f`)

`Matrix all` (*void*) *const*
`Matrix any` (*void*) *const*

`Matrix cumprod` (*void*) *const*
`Matrix cumsum` (*void*) *const*
`Matrix prod` (*void*) *const*
`Matrix sum` (*void*) *const*
`Matrix sumsq` (*void*) *const*

`ColumnVector diag` (*void*) *const*
`ColumnVector diag` (*int* `k`) *const*

`ColumnVector row_min` (*void*) *const*
`ColumnVector row_min_loc` (*void*) *const*

`ColumnVector row_max` (*void*) *const*
`ColumnVector row_max_loc` (*void*) *const*

`RowVector column_min` (*void*) *const*
`RowVector column_min_loc` (*void*) *const*

`RowVector column_max` (*void*) *const*
`RowVector column_max_loc` (*void*) *const*

`ostream& operator <<` (*ostream &*`os`, *const Matrix &*`a`)
`istream& operator >>` (*istream &*`is`, *Matrix &*`a`)

`ColumnVector` (*void*)
`ColumnVector` (*int* `n`)
`ColumnVector` (*int* `n`, *double* `val`)

`ColumnVector` (*const Array<double> &a*)
`ColumnVector` (*const ColumnVector &a*)

`ColumnVector& operator =` (*const ColumnVector &a*)

`int operator ==` (*const ColumnVector &a*) *const*
`int operator !=` (*const ColumnVector &a*) *const*

`ColumnVector& insert` (*const ColumnVector &a, int r*)

`ColumnVector& fill` (*double val*)
`ColumnVector& fill` (*double val, int r1, int r2*)

`ColumnVector stack` (*const ColumnVector &a*) *const*

`RowVector transpose` (*void*) *const*

`ColumnVector extract` (*int r1, int r2*) *const*

`ColumnVector& operator +=` (*const ColumnVector &a*)
`ColumnVector& operator -=` (*const ColumnVector &a*)

`ComplexColumnVector operator +` (*const ColumnVector &a, const Complex &s*)
`ComplexColumnVector operator -` (*const ColumnVector &a, const Complex &s*)
`ComplexColumnVector operator *` (*const ColumnVector &a, const Complex &s*)
`ComplexColumnVector operator /` (*const ColumnVector &a, const Complex &s*)

`ComplexColumnVector operator +` (*const Complex &s, const ColumnVector &a*)
`ComplexColumnVector operator -` (*const Complex &s, const ColumnVector &a*)
`ComplexColumnVector operator *` (*const Complex &s, const ColumnVector &a*)
`ComplexColumnVector operator /` (*const Complex &s, const ColumnVector &a*)

`Matrix operator *` (*const ColumnVector &a, const RowVector &a*)

`ComplexMatrix operator *` (*const ColumnVector &a, const ComplexRowVector &b*)

`ComplexColumnVector operator +` (*const ComplexColumnVector &a, const ComplexColumnVector &b*)

`ComplexColumnVector operator -` (*const ComplexColumnVector &a, const ComplexColumnVector &b*)

`ComplexColumnVector product` (*const ComplexColumnVector &a, const ComplexColumnVector &b*)

`ComplexColumnVector quotient` (*const ComplexColumnVector &a, const ComplexColumnVector &b*)

`ColumnVector map` (*d_d_Mapper f, const ColumnVector &a*)

`void map` (*d_d_Mapper* `f`)

`double min` (*void*) *const*
`double max` (*void*) *const*

`ostream& operator <<` (*ostream &os, const ColumnVector &a*)

`RowVector` (*void*)
`RowVector` (*int n*)
`RowVector` (*int n, double val*)
`RowVector` (*const Array<double> &a*)
`RowVector` (*const RowVector &a*)

`RowVector& operator =` (*const RowVector &a*)

`int operator ==` (*const RowVector &a*) *const*
`int operator !=` (*const RowVector &a*) *const*

`RowVector& insert` (*const RowVector &a, int c*)

`RowVector& fill` (*double val*)
`RowVector& fill` (*double val, int c1, int c2*)

`RowVector append` (*const RowVector &a*) *const*

`ColumnVector transpose` (*void*) *const*

`RowVector extract` (*int c1, int c2*) *const*

`RowVector& operator +=` (*const RowVector &a*)
`RowVector& operator -=` (*const RowVector &a*)

`ComplexRowVector operator +` (*const RowVector &a, const Complex &s*)
`ComplexRowVector operator -` (*const RowVector &a, const Complex &s*)
`ComplexRowVector operator *` (*const RowVector &a, const Complex &s*)
`ComplexRowVector operator /` (*const RowVector &a, const Complex &s*)

`ComplexRowVector operator +` (*const Complex &s, const RowVector &a*)
`ComplexRowVector operator -` (*const Complex &s, const RowVector &a*)
`ComplexRowVector operator *` (*const Complex &s, const RowVector &a*)
`ComplexRowVector operator /` (*const Complex &s, const RowVector &a*)

`double operator *` (*const RowVector &a, ColumnVector &b*)

`Complex operator *` (*const RowVector &a, const ComplexColumnVector &b*)

`RowVector operator *` (*const RowVector &a, const Matrix &b*)

`ComplexRowVector operator *` (*const RowVector &a, const ComplexMatrix &b*)

`ComplexRowVector operator +` (*const RowVector &a, const ComplexRowVector &b*)
`ComplexRowVector operator -` (*const RowVector &a, const ComplexRowVector &b*)

`ComplexRowVector product` (*const RowVector &a, const ComplexRowVector &b*)

`ComplexRowVector quotient` (*const RowVector &*`a`, *const ComplexRowVector &*`b`)

`RowVector map` (*d_d_Mapper* `f`, *const RowVector &*`a`)
`void map` (*d_d_Mapper* `f`)

`double min` (*void*) *const*
`double max` (*void*) *const*

`ostream& operator <<` (*ostream &*`os`, *const RowVector &*`a`)

`DiagMatrix` (*void*)
`DiagMatrix` (*int* `n`)
`DiagMatrix` (*int* `n`, *double* `val`)
`DiagMatrix` (*int* `r`, *int* `c`)
`DiagMatrix` (*int* `r`, *int* `c`, *double* `val`)
`DiagMatrix` (*const RowVector &*`a`)
`DiagMatrix` (*const ColumnVector &*`a`)
`DiagMatrix` (*const DiagArray<double> &*`a`)
`DiagMatrix` (*const DiagMatrix &*`a`)

`DiagMatrix& operator =` (*const DiagMatrix &*`a`)

`int operator ==` (*const DiagMatrix &*`a`) *const*
`int operator !=` (*const DiagMatrix &*`a`) *const*

`DiagMatrix& fill` (*double* `val`)
`DiagMatrix& fill` (*double* `val`, *int* `beg`, *int* `end`)
`DiagMatrix& fill` (*const ColumnVector &*`a`)
`DiagMatrix& fill` (*const RowVector &*`a`)
`DiagMatrix& fill` (*const ColumnVector &*`a`, *int* `beg`)
`DiagMatrix& fill` (*const RowVector &*`a`, *int* `beg`)

`DiagMatrix transpose` (*void*) *const*

`Matrix extract` (*int r1*, *int c1*, *int r2*, *int c2*) *const*

`RowVector row` (*int* `i`) *const*
`RowVector row` (*char *s*) *const*

`ColumnVector column` (*int* `i`) *const*
`ColumnVector column` (*char *s*) *const*

`DiagMatrix inverse` (*void*) *const*
`DiagMatrix inverse` (*int &*`info`) *const*

`DiagMatrix& operator +=` (*const DiagMatrix &*`a`)
`DiagMatrix& operator -=` (*const DiagMatrix &*`a`)

`Matrix operator +` (*const DiagMatrix &*`a`, *double* `s`)
`Matrix operator -` (*const DiagMatrix &*`a`, *double* `s`)

`ComplexMatrix operator +` (*const DiagMatrix &*`a`, *const Complex &*`s`)
`ComplexMatrix operator -` (*const DiagMatrix &*`a`, *const Complex &*`s`)

`ComplexDiagMatrix operator *` (*const DiagMatrix &*`a`, *const Complex &*`s`)

`ComplexDiagMatrix operator /` (*const DiagMatrix &*`a`, *const Complex &*`s`)

`Matrix operator +` (*double* `s`, *const DiagMatrix &*`a`)
`Matrix operator -` (*double* `s`, *const DiagMatrix &*`a`)

`ComplexMatrix operator +` (*const Complex &*`s`, *const DiagMatrix &*`a`)
`ComplexMatrix operator -` (*const Complex &*`s`, *const DiagMatrix &*`a`)

`ComplexDiagMatrix operator *` (*const Complex &*`s`, *const DiagMatrix &*`a`)

`ColumnVector operator *` (*const DiagMatrix &*`a`, *const ColumnVector &*`b`)

`ComplexColumnVector operator *` (*const DiagMatrix &*`a`, *const ComplexColumnVector &*`b`)

`ComplexDiagMatrix operator +` (*const DiagMatrix &*`a`, *const ComplexDiagMatrix &*`b`)
`ComplexDiagMatrix operator -` (*const DiagMatrix &*`a`, *const ComplexDiagMatrix &*`b`)

`ComplexDiagMatrix product` (*const DiagMatrix &*`a`, *const ComplexDiagMatrix &*`b`)

`Matrix operator +` (*const DiagMatrix &*`a`, *const Matrix &*`b`)
`Matrix operator -` (*const DiagMatrix &*`a`, *const Matrix &*`b`)
`Matrix operator *` (*const DiagMatrix &*`a`, *const Matrix &*`b`)

`ComplexMatrix operator +` (*const DiagMatrix &*`a`, *const ComplexMatrix &*`b`)
`ComplexMatrix operator -` (*const DiagMatrix &*`a`, *const ComplexMatrix &*`b`)
`ComplexMatrix operator *` (*const DiagMatrix &*`a`, *const ComplexMatrix &*`b`)

`ColumnVector diag` (*void*) *const*
`ColumnVector diag` (*int* `k`) *const*

`ostream& operator <<` (*ostream &*`os`, *const DiagMatrix &*`a`)

`ComplexMatrix` (*void*)
`ComplexMatrix` (*int* `r`, *int* `c`)
`ComplexMatrix` (*int* `r`, *int* `c`, *const Complex &*`val`)
`ComplexMatrix` (*const Matrix &*`a`)
`ComplexMatrix` (*const Array2<Complex> &*`a`)
`ComplexMatrix` (*const ComplexMatrix &*`a`)
`ComplexMatrix` (*const DiagMatrix &*`a`)
`ComplexMatrix` (*const DiagArray<Complex> &*`a`)
`ComplexMatrix` (*const ComplexDiagMatrix &*`a`)

`ComplexMatrix& operator =` (*const ComplexMatrix &*`a`)

`int operator ==` (*const ComplexMatrix &*`a`) *const*
`int operator !=` (*const ComplexMatrix &*`a`) *const*

`ComplexMatrix& insert` (*const Matrix &*`a`, *int* `r`, *int* `c`)
`ComplexMatrix& insert` (*const RowVector &*`a`, *int* `r`, *int* `c`)
`ComplexMatrix& insert` (*const ColumnVector &*`a`, *int* `r`, *int* `c`)
`ComplexMatrix& insert` (*const DiagMatrix &*`a`, *int* `r`, *int* `c`)

`ComplexMatrix& insert` (*const ComplexMatrix &*`a`, *int* `r`, *int* `c`)

`ComplexMatrix& insert` (*const ComplexRowVector &*`a`, *int* `r`, *int* `c`)
`ComplexMatrix& insert` (*const ComplexColumnVector &*`a`, *int* `r`, *int* `c`)
`ComplexMatrix& insert` (*const ComplexDiagMatrix &*`a`, *int* `r`, *int* `c`)

`ComplexMatrix& fill` (*double* `val`)
`ComplexMatrix& fill` (*const Complex &*`val`)
`ComplexMatrix& fill` (*double* `val`, *int r1*, *int c1*, *int r2*, *int c2*)
`ComplexMatrix& fill` (*const Complex &*`val`, *int r1*, *int c1*, *int r2*, *int c2*)

`ComplexMatrix append` (*const Matrix &*`a`) *const*
`ComplexMatrix append` (*const RowVector &*`a`) *const*
`ComplexMatrix append` (*const ColumnVector &*`a`) *const*
`ComplexMatrix append` (*const DiagMatrix &*`a`) *const*

`ComplexMatrix append` (*const ComplexMatrix &*`a`) *const*
`ComplexMatrix append` (*const ComplexRowVector &*`a`) *const*
`ComplexMatrix append` (*const ComplexColumnVector &*`a`) *const*
`ComplexMatrix append` (*const ComplexDiagMatrix &*`a`) *const*

`ComplexMatrix stack` (*const Matrix &*`a`) *const*
`ComplexMatrix stack` (*const RowVector &*`a`) *const*
`ComplexMatrix stack` (*const ColumnVector &*`a`) *const*
`ComplexMatrix stack` (*const DiagMatrix &*`a`) *const*

`ComplexMatrix stack` (*const ComplexMatrix &*`a`) *const*
`ComplexMatrix stack` (*const ComplexRowVector &*`a`) *const*
`ComplexMatrix stack` (*const ComplexColumnVector &*`a`) *const*
`ComplexMatrix stack` (*const ComplexDiagMatrix &*`a`) *const*

`ComplexMatrix transpose` (*void*) *const*

`Matrix real` (*const ComplexMatrix &*`a`)
`Matrix imag` (*const ComplexMatrix &*`a`)
`ComplexMatrix conj` (*const ComplexMatrix &*`a`)

`ComplexMatrix extract` (*int r1*, *int c1*, *int r2*, *int c2*) *const*

`ComplexRowVector row` (*int* `i`) *const*
`ComplexRowVector row` (*char *s*) *const*

`ComplexColumnVector column` (*int* `i`) *const*
`ComplexColumnVector column` (*char *s*) *const*

`ComplexMatrix inverse` (*void*) *const*
`ComplexMatrix inverse` (*int &*`info`) *const*
`ComplexMatrix inverse` (*int &*`info`, *double &*`rcond`) *const*

`ComplexMatrix fourier` (*void*) *const*
`ComplexMatrix ifourier` (*void*) *const*

`ComplexDET determinant` (*void*) *const*
`ComplexDET determinant` (*int &*`info`) *const*
`ComplexDET determinant` (*int &*`info`, *double &*`rcond`) *const*

`ComplexMatrix solve` (*const Matrix &*`b`) *const*

`ComplexMatrix solve` (*const Matrix &*`b`, *int &*`info`) *const*
`ComplexMatrix solve` (*const Matrix &*`b`, *int &*`info`, *double &*`rcond`) *const*

`ComplexMatrix solve` (*const ComplexMatrix &*`b`) *const*
`ComplexMatrix solve` (*const ComplexMatrix &*`b`, *int &*`info`) *const*
`ComplexMatrix solve` (*const ComplexMatrix &*`b`, *int &*`info`, *double &*`rcond`) *const*

`ComplexColumnVector solve` (*const ComplexColumnVector &*`b`) *const*
`ComplexColumnVector solve` (*const ComplexColumnVector &*`b`, *int &*`info`) *const*
`ComplexColumnVector solve` (*const ComplexColumnVector &*`b`, *int &*`info`, *double &*`rcond`) *const*

`ComplexMatrix lssolve` (*const ComplexMatrix &*`b`) *const*
`ComplexMatrix lssolve` (*const ComplexMatrix &*`b`, *int &*`info`) *const*
`ComplexMatrix lssolve` (*const ComplexMatrix &*`b`, *int &*`info`, *int &*`rank`) *const*

`ComplexColumnVector lssolve` (*const ComplexColumnVector &*`b`) *const*
`ComplexColumnVector lssolve` (*const ComplexColumnVector &*`b`, *int &*`info`) *const*
`ComplexColumnVector lssolve` (*const ComplexColumnVector &*`b`, *int &*`info`, *int &*`rank`) *const*

`ComplexMatrix& operator +=` (*const DiagMatrix &*`a`)
`ComplexMatrix& operator -=` (*const DiagMatrix &*`a`)

`ComplexMatrix& operator +=` (*const ComplexDiagMatrix &*`a`)
`ComplexMatrix& operator -=` (*const ComplexDiagMatrix &*`a`)

`ComplexMatrix& operator +=` (*const Matrix &*`a`)
`ComplexMatrix& operator -=` (*const Matrix &*`a`)

`ComplexMatrix& operator +=` (*const ComplexMatrix &*`a`)
`ComplexMatrix& operator -=` (*const ComplexMatrix &*`a`)

`Matrix operator !` (*void*) *const*

`ComplexMatrix operator +` (*const ComplexMatrix &*`a`, *double* `s`)
`ComplexMatrix operator -` (*const ComplexMatrix &*`a`, *double* `s`)
`ComplexMatrix operator *` (*const ComplexMatrix &*`a`, *double* `s`)
`ComplexMatrix operator /` (*const ComplexMatrix &*`a`, *double* `s`)

`ComplexMatrix operator +` (*double* `s`, *const ComplexMatrix &*`a`)
`ComplexMatrix operator -` (*double* `s`, *const ComplexMatrix &*`a`)
`ComplexMatrix operator *` (*double* `s`, *const ComplexMatrix &*`a`)
`ComplexMatrix operator /` (*double* `s`, *const ComplexMatrix &*`a`)

`ComplexColumnVector operator *` (*const ComplexMatrix &*`a`, *const ColumnVector &*`b`)

`ComplexColumnVector operator *` (*const ComplexMatrix &*`a`, *const ComplexColumnVector &*`b`)

`ComplexMatrix operator +` (*const ComplexMatrix &*`a`, *const DiagMatrix &*`b`)

`ComplexMatrix operator -` (*const ComplexMatrix &*`a`, *const DiagMatrix &*`b`)
`ComplexMatrix operator *` (*const ComplexMatrix &*`a`, *const DiagMatrix &*`b`)

`ComplexMatrix operator +` (*const ComplexMatrix &*`a`, *const ComplexDiagMatrix &*`b`)
`ComplexMatrix operator -` (*const ComplexMatrix &*`a`, *const ComplexDiagMatrix &*`b`)
`ComplexMatrix operator *` (*const ComplexMatrix &*`a`, *const ComplexDiagMatrix &*`b`)

`ComplexMatrix operator +` (*const ComplexMatrix &*`a`, *const Matrix &*`b`)
`ComplexMatrix operator -` (*const ComplexMatrix &*`a`, *const Matrix &*`b`)

`ComplexMatrix operator *` (*const ComplexMatrix &*`a`, *const Matrix &*`b`)
`ComplexMatrix operator *` (*const ComplexMatrix &*`a`, *const ComplexMatrix &*`b`)

`ComplexMatrix product` (*const ComplexMatrix &*`a`, *const Matrix &*`b`)
`ComplexMatrix quotient` (*const ComplexMatrix &*`a`, *const Matrix &*`b`)

`ComplexMatrix map` (*c_c_Mapper* `f`, *const ComplexMatrix &*`a`)
`Matrix map` (*d_c_Mapper* `f`, *const ComplexMatrix &*`a`)
`void map` (*c_c_Mapper* `f`)

`Matrix all` (*void*) *const*
`Matrix any` (*void*) *const*

`ComplexMatrix cumprod` (*void*) *const*
`ComplexMatrix cumsum` (*void*) *const*
`ComplexMatrix prod` (*void*) *const*
`ComplexMatrix sum` (*void*) *const*
`ComplexMatrix sumsq` (*void*) *const*

`ComplexColumnVector diag` (*void*) *const*
`ComplexColumnVector diag` (*int* `k`) *const*

`ComplexColumnVector row_min` (*void*) *const*
`ComplexColumnVector row_min_loc` (*void*) *const*

`ComplexColumnVector row_max` (*void*) *const*
`ComplexColumnVector row_max_loc` (*void*) *const*

`ComplexRowVector column_min` (*void*) *const*
`ComplexRowVector column_min_loc` (*void*) *const*

`ComplexRowVector column_max` (*void*) *const*
`ComplexRowVector column_max_loc` (*void*) *const*

`ostream& operator <<` (*ostream &*`os`, *const ComplexMatrix &*`a`)
`istream& operator >>` (*istream &*`is`, *ComplexMatrix &*`a`)

`ComplexColumnVector` (*void*)
`ComplexColumnVector` (*int* `n`)
`ComplexColumnVector` (*int* `n`, *const Complex &*`val`)
`ComplexColumnVector` (*const ColumnVector &*`a`)

`ComplexColumnVector` (*const Array<Complex> &a*)
`ComplexColumnVector` (*const ComplexColumnVector &a*)

`ComplexColumnVector& operator =` (*const ComplexColumnVector &a*)

`int operator ==` (*const ComplexColumnVector &a*) *const*
`int operator !=` (*const ComplexColumnVector &a*) *const*

`ComplexColumnVector& insert` (*const ColumnVector &a, int r*)
`ComplexColumnVector& insert` (*const ComplexColumnVector &a, int r*)

`ComplexColumnVector& fill` (*double val*)
`ComplexColumnVector& fill` (*const Complex &val*)
`ComplexColumnVector& fill` (*double val, int r1, int r2*)
`ComplexColumnVector& fill` (*const Complex &val, int r1, int r2*)

`ComplexColumnVector stack` (*const ColumnVector &a*) *const*
`ComplexColumnVector stack` (*const ComplexColumnVector &a*) *const*

`ComplexRowVector transpose` (*void*) *const*

`ColumnVector real` (*const ComplexColumnVector &a*)
`ColumnVector imag` (*const ComplexColumnVector &a*)
`ComplexColumnVector conj` (*const ComplexColumnVector &a*)

`ComplexColumnVector extract` (*int r1, int r2*) *const*

`ComplexColumnVector& operator +=` (*const ColumnVector &a*)
`ComplexColumnVector& operator -=` (*const ColumnVector &a*)

`ComplexColumnVector& operator +=` (*const ComplexColumnVector &a*)
`ComplexColumnVector& operator -=` (*const ComplexColumnVector &a*)

`ComplexColumnVector operator +` (*const ComplexColumnVector &a, double s*)
`ComplexColumnVector operator -` (*const ComplexColumnVector &a, double s*)
`ComplexColumnVector operator *` (*const ComplexColumnVector &a, double s*)
`ComplexColumnVector operator /` (*const ComplexColumnVector &a, double s*)

`ComplexColumnVector operator +` (*double s, const ComplexColumnVector &a*)
`ComplexColumnVector operator -` (*double s, const ComplexColumnVector &a*)
`ComplexColumnVector operator *` (*double s, const ComplexColumnVector &a*)
`ComplexColumnVector operator /` (*double s, const ComplexColumnVector &a*)

`ComplexMatrix operator *` (*const ComplexColumnVector &a, const ComplexRowVector &b*)

`ComplexColumnVector operator +` (*const ComplexColumnVector &*`a`, *const ColumnVector &*`b`)
`ComplexColumnVector operator -` (*const ComplexColumnVector &*`a`, *const ColumnVector &*`b`)

`ComplexColumnVector product` (*const ComplexColumnVector &*`a`, *const ColumnVector &*`b`)
`ComplexColumnVector quotient` (*const ComplexColumnVector &*`a`, *const ColumnVector &*`b`)

`ComplexColumnVector map` (*c_c_Mapper* `f`, *const ComplexColumnVector &*`a`)
`ColumnVector map` (*d_c_Mapper* `f`, *const ComplexColumnVector &*`a`)
`void map` (*c_c_Mapper* `f`)

`Complex min` (*void*) *const*
`Complex max` (*void*) *const*

`ostream& operator <<` (*ostream &*`os`, *const ComplexColumnVector &*`a`)

`ComplexRowVector` (*void*)
`ComplexRowVector` (*int* `n`)
`ComplexRowVector` (*int* `n`, *const Complex &*`val`)
`ComplexRowVector` (*const RowVector &*`a`)
`ComplexRowVector` (*const Array<Complex> &*`a`)
`ComplexRowVector` (*const ComplexRowVector &*`a`)

`ComplexRowVector& operator =` (*const ComplexRowVector &*`a`)

`int operator ==` (*const ComplexRowVector &*`a`) *const*
`int operator !=` (*const ComplexRowVector &*`a`) *const*

`ComplexRowVector& insert` (*const RowVector &*`a`, *int* `c`)
`ComplexRowVector& insert` (*const ComplexRowVector &*`a`, *int* `c`)

`ComplexRowVector& fill` (*double* `val`)
`ComplexRowVector& fill` (*const Complex &*`val`)
`ComplexRowVector& fill` (*double* `val`, *int c1*, *int c2*)
`ComplexRowVector& fill` (*const Complex &*`val`, *int c1*, *int c2*)

`ComplexRowVector append` (*const RowVector &*`a`) *const*
`ComplexRowVector append` (*const ComplexRowVector &*`a`) *const*

`ComplexColumnVector transpose` (*void*) *const*

`RowVector real` (*const ComplexRowVector &*`a`)
`RowVector imag` (*const ComplexRowVector &*`a`)
`ComplexRowVector conj` (*const ComplexRowVector &*`a`)

`ComplexRowVector extract` (*int c1*, *int c2*) *const*

`ComplexRowVector& operator +=` (*const RowVector &*`a`)
`ComplexRowVector& operator -=` (*const RowVector &*`a`)

`ComplexRowVector& operator +=` (*const ComplexRowVector &*`a`)
`ComplexRowVector& operator -=` (*const ComplexRowVector &*`a`)

`ComplexRowVector operator +` (*const ComplexRowVector &*`a`, *double* `s`)

`ComplexRowVector operator -` (*const ComplexRowVector &*`a`, *double* `s`)
`ComplexRowVector operator *` (*const ComplexRowVector &*`a`, *double* `s`)
`ComplexRowVector operator /` (*const ComplexRowVector &*`a`, *double* `s`)

`ComplexRowVector operator +` (*double* `s`, *const ComplexRowVector &*`a`)
`ComplexRowVector operator -` (*double* `s`, *const ComplexRowVector &*`a`)
`ComplexRowVector operator *` (*double* `s`, *const ComplexRowVector &*`a`)
`ComplexRowVector operator /` (*double* `s`, *const ComplexRowVector &*`a`)

`Complex operator *` (*const ComplexRowVector &*`a`, *const ColumnVector &*`b`)

`Complex operator *` (*const ComplexRowVector &*`a`, *const ComplexColumnVector &*`b`)

`ComplexRowVector operator *` (*const ComplexRowVector &*`a`, *const ComplexMatrix &*`b`)

`ComplexRowVector operator +` (*const ComplexRowVector &*`a`, *const RowVector &*`b`)
`ComplexRowVector operator -` (*const ComplexRowVector &*`a`, *const RowVector &*`b`)

`ComplexRowVector product` (*const ComplexRowVector &*`a`, *const RowVector &*`b`)
`ComplexRowVector quotient` (*const ComplexRowVector &*`a`, *const RowVector &*`b`)

`ComplexRowVector map` (*c_c_Mapper* `f`, *const ComplexRowVector &*`a`)
`RowVector map` (*d_c_Mapper* `f`, *const ComplexRowVector &*`a`)
`void map` (*c_c_Mapper* `f`)

`Complex min` (*void*) *const*
`Complex max` (*void*) *const*

`ostream& operator <<` (*ostream &*`os`, *const ComplexRowVector &*`a`)

`ComplexDiagMatrix` (*void*)
`ComplexDiagMatrix` (*int* `n`)
`ComplexDiagMatrix` (*int* `n`, *const Complex &*`val`)
`ComplexDiagMatrix` (*int* `r`, *int* `c`)
`ComplexDiagMatrix` (*int* `r`, *int* `c`, *const Complex &*`val`)
`ComplexDiagMatrix` (*const RowVector &*`a`)
`ComplexDiagMatrix` (*const ComplexRowVector &*`a`)
`ComplexDiagMatrix` (*const ColumnVector &*`a`)
`ComplexDiagMatrix` (*const ComplexColumnVector &*`a`)
`ComplexDiagMatrix` (*const DiagMatrix &*`a`)
`ComplexDiagMatrix` (*const DiagArray<Complex> &*`a`)
`ComplexDiagMatrix` (*const ComplexDiagMatrix &*`a`)

`ComplexDiagMatrix& operator =` (*const ComplexDiagMatrix &*`a`)

`int operator ==` (*const ComplexDiagMatrix &*`a`) *const*
`int operator !=` (*const ComplexDiagMatrix &*`a`) *const*

`ComplexDiagMatrix& fill` (*double* `val`)

`ComplexDiagMatrix& fill` (*const Complex &val*)
`ComplexDiagMatrix& fill` (*double val, int beg, int end*)
`ComplexDiagMatrix& fill` (*const Complex &val, int beg, int end*)
`ComplexDiagMatrix& fill` (*const ColumnVector &a*)
`ComplexDiagMatrix& fill` (*const ComplexColumnVector &a*)
`ComplexDiagMatrix& fill` (*const RowVector &a*)
`ComplexDiagMatrix& fill` (*const ComplexRowVector &a*)
`ComplexDiagMatrix& fill` (*const ColumnVector &a, int beg*)
`ComplexDiagMatrix& fill` (*const ComplexColumnVector &a, int beg*)
`ComplexDiagMatrix& fill` (*const RowVector &a, int beg*)
`ComplexDiagMatrix& fill` (*const ComplexRowVector &a, int beg*)

`ComplexDiagMatrix transpose` (*void*) *const*

`DiagMatrix real` (*const ComplexDiagMatrix &a*)
`DiagMatrix imag` (*const ComplexDiagMatrix &a*)
`ComplexDiagMatrix conj` (*const ComplexDiagMatrix &a*)

`ComplexMatrix extract` (*int r1, int c1, int r2, int c2*) *const*

`ComplexRowVector row` (*int i*) *const*
`ComplexRowVector row` (*char *s*) *const*

`ComplexColumnVector column` (*int i*) *const*
`ComplexColumnVector column` (*char *s*) *const*

`ComplexDiagMatrix inverse` (*int &info*) *const*
`ComplexDiagMatrix inverse` (*void*) *const*

`ComplexDiagMatrix& operator +=` (*const DiagMatrix &a*)
`ComplexDiagMatrix& operator -=` (*const DiagMatrix &a*)

`ComplexDiagMatrix& operator +=` (*const ComplexDiagMatrix &a*)
`ComplexDiagMatrix& operator -=` (*const ComplexDiagMatrix &a*)

`ComplexMatrix operator +` (*const ComplexDiagMatrix &a, double s*)
`ComplexMatrix operator -` (*const ComplexDiagMatrix &a, double s*)

`ComplexMatrix operator +` (*const ComplexDiagMatrix &a, const Complex &s*)
`ComplexMatrix operator -` (*const ComplexDiagMatrix &a, const Complex &s*)

`ComplexDiagMatrix operator *` (*const ComplexDiagMatrix &a, double s*)
`ComplexDiagMatrix operator /` (*const ComplexDiagMatrix &a, double s*)

`ComplexMatrix operator +` (*double s, const ComplexDiagMatrix &a*)
`ComplexMatrix operator -` (*double s, const ComplexDiagMatrix &a*)

`ComplexMatrix operator +` (*const Complex &s, const ComplexDiagMatrix &a*)
`ComplexMatrix operator -` (*const Complex &s, const ComplexDiagMatrix &a*)

`ComplexDiagMatrix operator *` (*double s, const ComplexDiagMatrix &a*)

`ComplexColumnVector operator *` (*const ComplexDiagMatrix &*`a`, *const ColumnVector &*`b`)

`ComplexColumnVector operator *` (*const ComplexDiagMatrix &*`a`, *const ComplexColumnVector &*`b`)

`ComplexDiagMatrix operator +` (*const ComplexDiagMatrix &*`a`, *const DiagMatrix &*`b`)
`ComplexDiagMatrix operator -` (*const ComplexDiagMatrix &*`a`, *const DiagMatrix &*`b`)

`ComplexDiagMatrix product` (*const ComplexDiagMatrix &*`a`, *const DiagMatrix &*`b`)

`ComplexMatrix operator +` (*const ComplexDiagMatrix &*`a`, *const Matrix &*`b`)
`ComplexMatrix operator -` (*const ComplexDiagMatrix &*`a`, *const Matrix &*`b`)
`ComplexMatrix operator *` (*const ComplexDiagMatrix &*`a`, *const Matrix &*`b`)

`ComplexMatrix operator +` (*const ComplexDiagMatrix &*`a`, *const ComplexMatrix &*`b`)
`ComplexMatrix operator -` (*const ComplexDiagMatrix &*`a`, *const ComplexMatrix &*`b`)
`ComplexMatrix operator *` (*const ComplexDiagMatrix &*`a`, *const ComplexMatrix &*`b`)

`ComplexColumnVector diag` (*void*) *const*
`ComplexColumnVector diag` (*int* `k`) *const*

`ostream& operator <<` (*ostream &*`os`, *const ComplexDiagMatrix &*`a`)

5 Matrix Factorizations

AEPBALANCE (*void*)
AEPBALANCE (*const Matrix &*a, *const char* **balance_job*)
AEPBALANCE (*const AEPBALANCE &*a)

AEPBALANCE& operator = (*const AEPBALANCE &*a)

Matrix balanced_matrix (*void*) *const*
Matrix balancing_matrix (*void*) *const*

ostream& operator << (*ostream &*os, *const AEPBALANCE &*a)

ComplexAEPBALANCE (*void*)
ComplexAEPBALANCE (*const ComplexMatrix &*a, *const char* **balance_job*)
ComplexAEPBALANCE (*const ComplexAEPBALANCE &*a)

ComplexAEPBALANCE& operator = (*const ComplexAEPBALANCE &*a)

ComplexMatrix balanced_matrix (*void*) *const*
ComplexMatrix balancing_matrix (*void*) *const*

ostream& operator << (*ostream &*os, *const ComplexAEPBALANCE &*a)

DET (*void*)
DET (*const DET &*a)

DET& operator = (*const DET &*a)

int value_will_overflow (*void*) *const*
int value_will_underflow (*void*) *const*

double coefficient (*void*) *const*
int exponent (*void*) *const*
double value (*void*) *const*

ostream& operator << (*ostream &*os, *const DET &*a)

ComplexDET (*void*)
ComplexDET (*const ComplexDET &*a)

ComplexDET& operator = (*const ComplexDET &*a)

int value_will_overflow (*void*) *const*
int value_will_underflow (*void*) *const*

Complex coefficient (*void*) *const*
int exponent (*void*) *const*
Complex value (*void*) *const*

ostream& operator << (*ostream &*os, *const ComplexDET &*a)

GEPBALANCE (*void*)
GEPBALANCE (*const Matrix &*a, *const Matrix &, const char* **balance_job*)
GEPBALANCE (*const GEPBALANCE &*a)

GEPBALANCE& operator = (*const GEPBALANCE &*a)

`Matrix balanced_a_matrix` (*void*) *const*
`Matrix balanced_b_matrix` (*void*) *const*
`Matrix left_balancing_matrix` (*void*) *const*
`Matrix right_balancing_matrix` (*void*) *const*

`ostream& operator <<` (*ostream &os, const GEPBALANCE &a*)

`CHOL` (*void*)
`CHOL` (*const Matrix &a*)
`CHOL` (*const Matrix &a, int &info*)
`CHOL` (*const CHOL &a*)

`CHOL& operator =` (*const CHOL &a*)

`Matrix chol_matrix` (*void*) *const*

`ostream& operator <<` (*ostream &os, const CHOL &a*)

`ComplexCHOL` (*void*)
`ComplexCHOL` (*const ComplexMatrix &a*)
`ComplexCHOL` (*const ComplexMatrix &a, int &info*)
`ComplexCHOL` (*const ComplexCHOL &a*)

`ComplexCHOL& operator =` (*const ComplexCHOL &a*)

`ComplexMatrix chol_matrix` (*void*) *const*

`ostream& operator <<` (*ostream &os, const ComplexCHOL &a*)

`HESS` (*void*)
`HESS` (*const Matrix &a*)
`HESS` (*const Matrix&a, int &info*)
`HESS` (*const HESS &a*)

`HESS& operator =` (*const HESS &a*)

`Matrix hess_matrix` (*void*) *const*
`Matrix unitary_hess_matrix` (*void*) *const*

`ostream& operator <<` (*ostream &os, const HESS &a*)

`ComplexHESS` (*void*)
`ComplexHESS` (*const ComplexMatrix &a*)
`ComplexHESS` (*const ComplexMatrix &a, int &info*)
`ComplexHESS` (*const ComplexHESS &a*)

`ComplexHESS& operator =` (*const ComplexHESS &a*)

`ComplexMatrix hess_matrix` (*void*) *const*
`ComplexMatrix unitary_hess_matrix` (*void*) *const*

`ostream& operator <<` (*ostream &os, const ComplexHESS &a*)

`SCHUR` (*void*)
`SCHUR` (*const Matrix &a, const char *ord*)
`SCHUR` (*const Matrix &a, const char *ord, int &info*)
`SCHUR` (*const SCHUR &a, const char *ord*)

`SCHUR& operator =` (*const SCHUR &a*)

`Matrix schur_matrix` (*void*) *const*
`Matrix unitary_matrix` (*void*) *const*

`ostream& operator <<` (*ostream &os, const SCHUR &a*)

`ComplexSCHUR` (*void*)
`ComplexSCHUR` (*const ComplexMatrix &a, const char *ord*)
`ComplexSCHUR` (*const ComplexMatrix &a, const char *ord, int &info*)
`ComplexSCHUR` (*const ComplexSCHUR &a, const char *ord*)

`ComplexSCHUR& operator =` (*const ComplexSCHUR &a*)

`ComplexMatrix schur_matrix` (*void*) *const*
`ComplexMatrix unitary_matrix` (*void*) *const*

`ostream& operator <<` (*ostream &os, const ComplexSCHUR &a*)

`SVD` (*void*)
`SVD` (*const Matrix &a*)
`SVD` (*const Matrix &a, int &info*)
`SVD` (*const SVD &a*)

`SVD& operator =` (*const SVD &a*)

`DiagMatrix singular_values` (*void*) *const*
`Matrix left_singular_matrix` (*void*) *const*
`Matrix right_singular_matrix` (*void*) *const*

`ostream& operator <<` (*ostream &os, const SVD &a*)

`ComplexSVD` (*void*)
`ComplexSVD` (*const ComplexMatrix &a*)
`ComplexSVD` (*const ComplexMatrix &a, int &info*)
`ComplexSVD` (*const ComplexSVD &a*)

`ComplexSVD& operator =` (*const ComplexSVD &a*)

`DiagMatrix singular_values` (*void*) *const*
`ComplexMatrix left_singular_matrix` (*void*) *const*
`ComplexMatrix right_singular_matrix` (*void*) *const*

`ostream& operator <<` (*ostream &os, const ComplexSVD &a*)

`EIG` (*void*)
`EIG` (*const Matrix &a*)
`EIG` (*const Matrix &a, int &info*)
`EIG` (*const ComplexMatrix &a*)
`EIG` (*const ComplexMatrix &a, int &info*)
`EIG` (*const EIG &a*)

`EIG& operator =` (*const EIG &a*)

`ComplexColumnVector eigenvalues` (*void*) *const*

`ComplexMatrix eigenvectors` (*void*) *const*

`ostream& operator <<` (*ostream &os, const EIG &a*)

`LU` (*void*)
`LU` (*const Matrix &*`a`)
`LU` (*const LU &*`a`)

`LU& operator =` (*const LU &*`a`)

`Matrix L` (*void*) *const*
`Matrix U` (*void*) *const*
`Matrix P` (*void*) *const*

`ostream& operator <<` (*ostream &*`os`, *const LU &*`a`)

`ComplexLU` (*void*)
`ComplexLU` (*const ComplexMatrix &*`a`)
`ComplexLU` (*const ComplexLU &*`a`)

`ComplexLU& operator =` (*const ComplexLU &*`a`)

`ComplexMatrix L` (*void*) *const*
`ComplexMatrix U` (*void*) *const*
`Matrix P` (*void*) *const*

`ostream& operator <<` (*ostream &*`os`, *const ComplexLU &*`a`)

`QR` (*void*)
`QR` (*const Matrix &*`A`)
`QR` (*const QR &*`a`)

`QR& operator =` (*const QR &*`a`)

`Matrix Q` (*void*) *const*
`Matrix R` (*void*) *const*

`ostream& operator <<` (*ostream &*`os`, *const QR &*`a`)

`ComplexQR` (*void*)
`ComplexQR` (*const ComplexMatrix &*`A`)
`ComplexQR` (*const ComplexQR &*`a`)

`ComplexQR& operator =` (*const ComplexQR &*`a`)

`ComplexMatrix Q` (*void*) *const*
`ComplexMatrix R` (*void*) *const*

`ostream& operator <<` (*ostream &*`os`, *const ComplexQR &*`a`)

6 Ranges

`Range` (*void*)
`Range` (*const Range &*`r`)
`Range` (*double* `b`, *double* `l`)
`Range` (*double* `b`, *double* `l`, *double* `i`)

`double base` (*void*) *const*
`double limit` (*void*) *const*
`double inc` (*void*) *const*

`void set_base` (*double* `b`)
`void set_limit` (*double* `l`)
`void set_inc` (*double* `i`)

`int nelem` (*void*) *const*

`double min` (*void*) *const*
`double max` (*void*) *const*

`void sort` (*void*)

`ostream& operator <<` (*ostream &*`os`, *const Range &*`r`)
`istream& operator >>` (*istream &*`is`, *Range &*`r`)

`void print_range` (*void*)

7 Nonlinear Functions

`NLFunc` (*void*)
`NLFunc` (*const* ***`nonlinear_fcn`***)
`NLFunc` (*const* ***`nonlinear_fcn`***, *const* `jacobian_fcn`)
`NLFunc` (*const NLFunc &*`a`)

`NLFunc& operator =` (*const NLFunc &*`a`)

`nonlinear_fcn function` (*void*) *const;*

`NLFunc& set_function` (*const nonlinear_fcn* `f`)

`jacobian_fcn jacobian_function` (*void*) *const;*

`NLFunc& set_jacobian_function` (*const jacobian_fcn* `j`)

8 Nonlinear Equations

`NLEqn_options` (*void*)
`NLEqn_options` (*const NLEqn_options &*`opt`)

`NLEqn_options& operator =` (*const NLEqn_options &*`opt`)

`void init` (*void*)

`void copy` (*const NLEqn_options &*`opt`)

`void set_default_options` (*void*)

`void set_tolerance` (*double* `val`)

`double tolerance` (*void*)

`NLEqn` (*void*)
`NLEqn` (*const ColumnVector&, const* `NLFunc`)
`NLEqn` (*const NLEqn &*`a`)

`NLEqn& operator =` (*const NLEqn &*`a`)

`void resize` (*int* `n`)

`void set_states` (*const ColumnVector &*`x`)

`ColumnVector states` (*void*) *const*

`int size` (*void*) *const*

`ColumnVector solve` (*void*)
`ColumnVector solve` (*const ColumnVector &*`x`)

`ColumnVector solve` (*int &*`info`)
`ColumnVector solve` (*const ColumnVector &*`x`, *int &*`info`)

9 Optimization

9.1 Objective Functions

`Objective` (*void*)
`Objective` (*const* `objective_fcn`)
`Objective` (*const* `objective_fcn`, *const* `gradient_fcn`)
`Objective` (*const Objective &*`a`)

`Objective& operator =` (*const Objective &*`a`)

`objective_fcn objective_function` (*void*) *const;*

`Objective& set_objective_function` (*const* `objective_fcn`)

`gradient_fcn gradient_function` (*void*) *const;*

`Objective& set_gradient_function` (*const* `gradient_fcn`)

9.2 Bounds

`Bounds` (*void*)
`Bounds` (*int* `n`)
`Bounds` (*const ColumnVector* `lb`, *const ColumnVector* `ub`)
`Bounds` (*const Bounds &*`a`)

`Bounds& operator =` (*const Bounds &*`a`)

`Bounds& resize` (*int* `n`)

`double lower_bound` (*int* `index`) *const;*
`double upper_bound` (*int* `index`) *const;*

`ColumnVector lower_bounds` (*void*) *const;*
`ColumnVector upper_bounds` (*void*) *const;*

`int size` (*void*) *const;*

`Bounds& set_bound` (*int* `index`, *double* `low`, *double* `high`)

`Bounds& set_bounds` (*double* `low`, *double* `high`)
`Bounds& set_bounds` (*const ColumnVector* `lb`, *const ColumnVector* `ub`)

`Bounds& set_lower_bound` (*int* `index`, *double* `low`)
`Bounds& set_upper_bound` (*int* `index`, *double* `high`)

`Bounds& set_lower_bounds` (*double* `low`)
`Bounds& set_upper_bounds` (*double* `high`)

`Bounds& set_lower_bounds` (*const ColumnVector* `lb`)
`Bounds& set_upper_bounds` (*const ColumnVector* `ub`)

`ostream& operator <<` (*ostream &*`os`, *const Bounds &*`b`)

9.3 Linear Constraints

`LinConst` (*void*)
`LinConst` (*int* `nclin`, *int* `nx`)
`LinConst` (*int* `nclin_eq`, *int* `nclin_ineq`, *int* `nx`)
`LinConst` (*const ColumnVector &*`lb`, *const Matrix &*`A`, *const ColumnVector &*`ub`)
`LinConst` (*const Matrix &*`A_eq`, *const ColumnVector &*`b_eq`, *const Matrix &*`A_ineq`, *const ColumnVector &*`b_ineq`)
`LinConst` (*const LinConst &*`a`)

`LinConst& operator =` (*const LinConst &*`a`)

`LinConst& resize` (*int* `nclin`, *int* `n`)

`Matrix constraint_matrix` (*void*) *const;*

`LinConst& set_constraint_matrix` (*const Matrix &*`A`)

`Matrix eq_constraint_matrix` (*void*) *const;*
`Matrix ineq_constraint_matrix` (*void*) *const;*

`ColumnVector eq_constraint_vector` (*void*) *const;*
`ColumnVector ineq_constraint_vector` (*void*) *const;*

`ostream& operator <<` (*ostream &*`os`, *const LinConst &*`b`)

9.4 Nonlinear Constraints

`NLConst` (*void*)
`NLConst` (*int* `n`)
`NLConst` (*const ColumnVector* `lb`, *const NLFunc* `f`, *const ColumnVector* `ub`)
`NLConst` (*const NLConst &*`a`)

`NLConst& operator =` (*const NLConst &*`a`)

9.5 Quadratic Programming

`QP` (*void*)
`QP` (*const ColumnVector &*`x`, *const Matrix &*`H`)
`QP` (*const ColumnVector &*`x`, *const Matrix &*`H`, *const ColumnVector &*`c`)
`QP` (*const ColumnVector &*`x`, *const Matrix &*`H`, *const Bounds &*`b`)
`QP` (*const ColumnVector &*`x`, *const Matrix &*`H`, *const LinConst &*`lc`)
`QP` (*const ColumnVector &*`x`, *const Matrix &*`H`, *const ColumnVector &*`c`, *const Bounds &*`b`)
`QP` (*const ColumnVector &*`x`, *const Matrix &*`H`, *const ColumnVector &*`c`, *const LinConst &*`lc`)
`QP` (*const ColumnVector &*`x`, *const Matrix &*`H`, *const Bounds &*`b`, *const LinConst &*`lc`)
`QP` (*const ColumnVector &*`x`, *const Matrix &*`H`, *const ColumnVector &*`c`, *const Bounds &*`b`, *const LinConst &*`lc`)

`virtual ColumnVector minimize` (*void*)

`virtual ColumnVector minimize` (*double &objf*)
`virtual ColumnVector minimize` (*double &objf*, *int &inform*)
`virtual ColumnVector minimize` (*double &objf*, *int &inform*, *ColumnVector &lambda*) = *0;*

`virtual ColumnVector minimize` (*const ColumnVector &x*)
`virtual ColumnVector minimize` (*const ColumnVector &x*, *double &objf*)
`virtual ColumnVector minimize` (*const ColumnVector &x*, *double &objf*, *int &inform*)
`virtual ColumnVector minimize` (*const ColumnVector &x*, *double &objf*, *int &inform*, *ColumnVector &lambda*)

`ColumnVector minimize` (*double &objf*, *int &inform*, *ColumnVector &lambda*)

9.6 Nonlinear Programming

`NLP` (*void*)
`NLP` (*const ColumnVector &x*, *const Objective &phi*)
`NLP` (*const ColumnVector &x*, *const Objective &phi*, *const Bounds &b*)
`NLP` (*const ColumnVector &x*, *const Objective &phi*, *const Bounds &b*, *const LinConst &lc*)
`NLP` (*const ColumnVector &x*, *const Objective &phi*, *const Bounds &b*, *const LinConst &lc*, *const NLConst &nlc*)
`NLP` (*const ColumnVector &x*, *const Objective &phi*, *const LinConst &lc*)
`NLP` (*const ColumnVector &x*, *const Objective &phi*, *const LinConst &lc*, *const NLConst &nlc*)
`NLP` (*const ColumnVector &x*, *const Objective &phi*, *const NLConst &nlc*)
`NLP` (*const ColumnVector &x*, *const Objective &phi*, *const Bounds &b*, *const NLConst &nlc*)

`NLP& operator =` (*const NLP &a*)

`int size` (*void*) *const*

`ColumnVector minimize` (*void*)
`ColumnVector minimize` (*double &objf*)
`ColumnVector minimize` (*double &objf*, *int &inform*)
`ColumnVector minimize` (*double &objf*, *int &inform*, *ColumnVector &lambda*)

`ColumnVector minimize` (*const ColumnVector &x*)
`ColumnVector minimize` (*const ColumnVector &x*, *double &objf*)
`ColumnVector minimize` (*const ColumnVector &x*, *double &objf*, *int &inform*)
`ColumnVector minimize` (*const ColumnVector &x*, *double &objf*, *int &inform*, *ColumnVector &lambda*)

10 Quadrature

`Quad` (*integrand_fcn* `fcn`)
`Quad` (*integrand_fcn* `fcn`, *double* `abs`, *double* `rel`)

`virtual double integrate` (*void*)
`virtual double integrate` (*int &*`ier`)
`virtual double integrate` (*int &*`ier`, *int &*`neval`)
`virtual double integrate` (*int &*`ier`, *int &*`neval`, *double &*`abserr`) = *0*

`Quad_options` (*void*)
`Quad_options` (*const Quad_options &*`opt`)

`Quad_options& operator =` (*const Quad_options &*`opt`)

`void init` (*void*)

`void copy` (*const Quad_options &*`opt`)

`void set_default_options` (*void*)

`void set_absolute_tolerance` (*double* `val`)

`void set_relative_tolerance` (*double* `val`)

`double absolute_tolerance` (*void*)
`double relative_tolerance` (*void*)

`DefQuad` (*integrand_fcn* `fcn`)
`DefQuad` (*integrand_fcn* `fcn`, *double* `ll`, *double* `ul`)
`DefQuad` (*integrand_fcn* `fcn`, *double* `ll`, *double* `ul`, *double* `abs`, *double* `rel`)
`DefQuad` (*integrand_fcn* `fcn`, *double* `ll`, *double* `ul`, *const ColumnVector &*`sing`)
`DefQuad` (*integrand_fcn* `fcn`, *const ColumnVector &*`sing`, *double* `abs`, *double* `rel`)
`DefQuad` (*integrand_fcn* `fcn`, *const ColumnVector &*`sing`)
`DefQuad` (*integrand_fcn* `fcn`, *double* `ll`, *double* `ul`, *const ColumnVector &*`sing`, *double* `abs`, *double* `rel`)

`IndefQuad` (*integrand_fcn* `fcn`)
`IndefQuad` (*integrand_fcn* `fcn`, *double* `b`, *IntegralType* `t`)
`IndefQuad` (*integrand_fcn* `fcn`, *double* `b`, *IntegralType* `t`, *double* `abs`, *double* `rel`)
`IndefQuad` (*integrand_fcn* `fcn`, *double* `abs`, *double* `rel`)

10.1 Collocation Weights

`CollocWt` (*void*)
`CollocWt` (*int* `n`, *int* `inc_l`, *int* `inc_r`)
`CollocWt` (*int* `n`, *int* `inc_l`, *int* `inc_r`, *double* `l`, *double* `r`)
`CollocWt` (*int* `n`, *double* `a`, *double* `b`, *int* `inc_l`, *int* `inc_r`)
`CollocWt` (*int* `n`, *int* `inc_l`, *int* `inc_r`, *double* `l`, *double* `r`)
`CollocWt` (*const CollocWt&*)

`CollocWt& operator =` (*const CollocWt&*)

`CollocWt& resize` (*int* `ncol`)

`CollocWt& add_left` (*void*)
`CollocWt& add_right` (*void*)

`CollocWt& delete_left` (*void*)
`CollocWt& delete_right` (*void*)

`CollocWt& set_left` (*double* `val`)
`CollocWt& set_right` (*double* `val`)

`CollocWt& set_alpha` (*double* `val`)
`CollocWt& set_beta` (*double* `val`)

`int ncol` (*void*) *const*

`int left_included` (*void*) *const*
`int right_included` (*void*) *const*

`double left` (*void*) *const*
`double right` (*void*) *const*
`double width` (*void*) *const*

`double alpha` (*void*) *const*
`double beta` (*void*) *const*

`ColumnVector roots` (*void*)
`ColumnVector quad` (*void*)
`ColumnVector quad_weights` (*void*)

`Matrix first` (*void*)
`Matrix second` (*void*)

`ostream& operator <<` (*ostream &*`os`, *const CollocWt &*`c`)

11 Ordinary Differential Equations

`ODE_options` (*void*)
`ODE_options` (*const ODE_options &*`opt`)

`ODE_options& operator =` (*const ODE_options &*`opt`)

`void init` (*void*)

`void copy` (*const ODE_options &*`opt`)

`void set_default_options` (*void*)

`void set_absolute_tolerance` (*double* `val`)

`void set_initial_step_size` (*double* `val`)

`void set_maximum_step_size` (*double* `val`)

`void set_minimum_step_size` (*double* `val`)

`void set_relative_tolerance` (*double* `val`)

`double absolute_tolerance` (*void*)
`double initial_step_size` (*void*)
`double maximum_step_size` (*void*)
`double minimum_step_size` (*void*)
`double relative_tolerance` (*void*)

`ODE` (*void*)
`ODE` (*int* `n`)
`ODE` (*const ColumnVector &*`state`, *double* `time`, *const ODEFunc &*`f`)

`virtual int size` (*void*) *const*

`virtual ColumnVector state` (*void*) *const*

`virtual double time` (*void*) *const*

`virtual void force_restart` (*void*)

`virtual void initialize` (*const ColumnVector &*`x`, *double* `t`)

`virtual void set_stop_time` (*double* `t`)

`virtual void clear_stop_time` (*void*)

`virtual ColumnVector integrate` (*double* `t`)

`void integrate` (*int* `nsteps`, *double* `tstep`, *ostream &*`s`)

`Matrix integrate` (*const ColumnVector &*`tout`)
`Matrix integrate` (*const ColumnVector &*`tout`, *const ColumnVector &*`tcrit`)

12 Differential Algebraic Equations

`DAE` (*void*)
`DAE` (*int* `n`)
`DAE` (*const ColumnVector &*`x`, *double* `time`, *DAEFunc &*`f`)
`DAE` (*const ColumnVector &*`x`, *ColumnVector &*`xdot`, *double* `time`, *DAEFunc &*`f`)

`ColumnVector deriv` (*void*)

`virtual void initialize` (*const ColumnVector &*`x`, *double* `t`)
`virtual void initialize` (*const ColumnVector &*`x`, *ColumnVector &*`xdot`, *double* `t`)

`ColumnVector integrate` (*double* `t`)

`Matrix integrate` (*const ColumnVector &*`tout`, *Matrix &*`xdot_out`)
`Matrix integrate` (*const ColumnVector &*`tout`, *Matrix &*`xdot_out`, *const ColumnVector &*`tcrit`)

13 Error Handling

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