Octave C++ Classes

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1 Acknowledgements

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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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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 48).

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 48).

`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 48.

`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*) Assginment 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

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

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

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

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

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

(**void**)
(**int** *n*)
(**int** *n*, const Complex &*val*)
(**const** ColumnVector &*a*)
(**const** Array<Complex> &*a*)
(**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)

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

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

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

(**void**)
(**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*)

(**void**)
(**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*)

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

(**void**)
(**const** *nonlinear_fcn*)
(**const** *nonlinear_fcn*, `const` *jacobian_fcn*)
(**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

(**void**)
(**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`)

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

(**void**)
(**const** *objective_fcn*)
(**const** *objective_fcn*, `const` *gradient_fcn*)
(**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

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

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

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

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

9.5 Quadratic Programming

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

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

(**integrand_fcn** *fcn*)
(**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`)

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

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

10.1 Collocation Weights

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

(**void**)
(**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`)

(**void**)
(**int** *n*)
(**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

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

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