Octave C++ Classes

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Table of Contents

1 Acknowledgements 1

Contributors to Octave 1

GNU GENERAL PUBLIC LICENSE 2

Preamble 2

TERMS AND CONDITIONS FOR COPYING, DISTRIBUTION AND MODIFICATION 3

Appendix: How to Apply These Terms to Your New Programs .. 7

2 A Brief Introduction to Octave 9

3 Arrays 10

3.1 Constructors and Assignment 10

4 Matrix and Vector Operations 15

5 Matrix Factorizations 32

6 Ranges 37

7 Nonlinear Functions 38

8 Nonlinear Equations 39

9 Optimization 40

9.1 Objective Functions 40

9.2 Bounds 40

9.3 Linear Constraints 41

9.4 Nonlinear Constraints 41

9.5 Quadratic Programming 42

9.6 Nonlinear Programming 42

10 Quadrature 44

10.1 Collocation Weights 45

11 Ordinary Differential Equations 46

12 Differential Algebraic Equations 47

13 Error Handling 48

14 Installation 49

15 Bugs 50

Concept Index 51

Function Index 52

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*)

13 Error Handling

14 Installation

15 Bugs

Concept Index

A

acknowledgements 1
arrays 10

B

bounds 40
bugs, known 50

C

collocation weights 45
contributors 1
copyright 1

D

DAE 47

F

factorizations 32

I

installation 49
installation trouble 50
integration 44
introduction 9

K

known causes of trouble 50

L

linear Constraints 41

M

matrix factorizations 32
matrix manipulations 15

N

NLP 42
nonlinear Constraints 41
nonlinear equations 39
nonlinear functions 38
nonlinear programming 42
numerical integration 44

O

objective functions 40
ODE 46
optimization 40
orthogonal collocation 45

Q

QP 42
quadratic programming 42
quadrature 44

R

ranges 37

T

troubleshooting 50

V

vector manipulations 15

W

warranty 1

Function Index

(

(const ... 15, 18, 19, 21, 22, 26, 28, 29, 32, 33, 34, 35, 36, 37, 38, 39, 40, 41, 42, 44, 45, 46, 47
(const on DiagArray<T>& ... 12
(double ... 37
(int .. 15, 18, 19, 21, 22, 26, 28, 29, 40, 41, 45, 46, 47
(integrand_fcn ... 44
(void) ... 15, 18, 19, 21, 22, 26, 27, 29, 32, 33, 34, 35, 36, 37, 38, 39, 40, 41, 42, 44, 45, 46, 47

A

absolute_tolerance ... 44, 46
add_left ... 45
add_right ... 45
all ... 17, 25
alpha ... 45
any ... 17, 25
append ... 15, 20, 23, 28
Array<T> ... 10
Array2<T> ... 11
Array3<T> ... 11

B

balanced_a_matrix ... 33
balanced_b_matrix ... 33
balanced_matrix ... 32
balancing_matrix ... 32
base ... 37
beta ... 45

C

capacity on Array<T> ... 10
checkelem on Array<T> ... 10
checkelem on Array2<T> ... 11
checkelem on Array3<T> ... 11
checkelem on DiagArray<T> ... 12
chol_matrix ... 33
clear_stop_time ... 46
coefficient ... 32
cols on Array2<T> ... 11
cols on DiagArray<T> ... 12
column ... 15, 21, 23, 30
column_max ... 18, 26
column_max_loc ... 18, 26
column_min ... 18, 26
column_min_loc ... 18, 26
columns on Array2<T> ... 11
columns on DiagArray<T> ... 12
conj ... 23, 26, 28, 30
constraint_matrix ... 41
copy ... 39, 44, 46
cumprod ... 17, 25
cumsum ... 17, 25

D

data on Array<T> ... 11
delete_left ... 45
delete_right ... 45
deriv ... 47
determinant ... 16, 24
diag ... 18, 22, 26, 31
DiagArray<T> ... 12
dim1 on Array2<T> ... 11
dim1 on Array3<T> ... 11
dim1 on DiagArray<T> ... 12
dim2 on Array2<T> ... 11
dim2 on Array3<T> ... 11
dim2 on DiagArray<T> ... 12
dim3 on Array3<T> ... 11

E

eigenvalues ... 35
eigenvectors ... 35
elem on Array<T> ... 10
elem on Array2<T> ... 11
elem on Array3<T> ... 11
elem on DiagArray<T> ... 12
eq_constraint_matrix ... 41
eq_constraint_vector ... 41
exponent ... 32
extract ... 15, 18, 20, 21, 23, 26, 28, 30

F

fill ... 15, 18, 19, 21, 23, 26, 28, 29, 30
first ... 45
force_restart ... 46
fourier ... 16, 24
function ... 38

G

gradient_function ... 40

H

hess_matrix ... 33, 34

I

ifourier 16, 24
imag 23, 26, 28, 30
inc 37
ineq_constraint_matrix 41
ineq_constraint_vector 41
init 39, 44, 46
initial_step_size 46
initialize 46, 47
insert 15, 18, 19, 22, 23, 26, 28
integrate 44, 46, 47
inverse 15, 21, 23, 30

J

jacobian_function 38

L

L 35
left 45
left_balancing_matrix 33
left_included 45
left_singular_matrix 34, 35
length on Array<T> 10
limit 37
lower_bound 40
lower_bounds 40
lssolve 16, 24

M

map 17, 19, 20, 25, 27, 29
max 19, 20, 27, 29, 37
maximum_step_size 46
min 19, 20, 27, 29, 37
minimize 42, 43
minimum_step_size 46

N

ncol 45
nelem 37

O

objective_function 40
operator 12, 13, 14, 15, 16, 17, 18, 19, 20, 21, 22, 24, 25, 26, 27, 28, 29, 30, 31, 32, 33, 34, 35, 36, 37, 38, 39, 40, 41, 43, 44, 45, 46
operator () on Array<T> 10
operator () on Array2<T> 11
operator () on Array3<T> 11
operator () on DiagArray<T> 12
operator = on Array<T> 10
operator = on Array2<T> 11
operator = on Array3<T> 11

P

P 35
print_range 37
prod 17, 25
product 13, 14, 17, 19, 20, 22, 25, 27, 29, 31

Q

Q 36
quad 45
quad_weights 45
quotient 13, 17, 19, 20, 25, 27, 29

R

R 36
real 23, 26, 28, 30
relative_tolerance 44, 46
resize 39, 40, 41, 45
resize on Array<T> 11
resize on Array2<T> 11
resize on Array3<T> 12
resize on DiagArray<T> 12
right 45
right_balancing_matrix 33
right_included 45
right_singular_matrix 34, 35
roots 45
row 15, 21, 23, 30
row_max 18, 26
row_max_loc 18, 26
row_min 18, 26
row_min_loc 18, 26
rows on Array2<T> 11
rows on DiagArray<T> 12

S

schur_matrix 34
second 45
set_absolute_tolerance 44, 46
set_alpha 45
set_base 37
set_beta 45
set_bound 40
set_bounds 40
set_constraint_matrix 41
set_default_options 39, 44, 46
set_function 38
set_gradient_function 40
set_inc 37
set_initial_step_size 46
set_jacobian_function 38
set_left 45
set_limit 37
set_lower_bound 40
set_lower_bounds 41
set_maximum_step_size 46
set_minimum_step_size 46
set_objective_function 40
set_relative_tolerance 44, 46
set_right 45
set_states 39
set_stop_time 46
set_tolerance 39
set_upper_bound 40
set_upper_bounds 41
singular_values 34, 35
size 39, 40, 43, 46
solve 16, 24, 39
sort 37
stack 15, 18, 23, 26
state 46
states 39
sum 17, 25
sumsq 17, 25

T

time 46
tolerance 39
transpose 15, 18, 20, 21, 23, 26, 28, 30

U

U 35
unitary_hess_matrix 33, 34
unitary_matrix 34
upper_bound 40
upper_bounds 40

V

value 32
value_will_overflow 32
value_will_underflow 32

W

width 45

X

xelem on Array<T> 10