Octave C++ Classes

Edition 1.0 for Octave version 11.1.0

The Octave Project Developers

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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 47).

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

Element by element vector by scalar ops.

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

Element by element scalar by vector ops.

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

Element by element vector by vector ops.

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

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

Unary MArray ops.

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

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

Element by element matrix by scalar ops.

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

Element by element scalar by matrix ops.

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

Element by element matrix by matrix ops.

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

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

Unary matrix ops.

```
Matrix operator - (const Matrix &a)
```

The `DiagMatrix` classes share the following functions. These will eventually be part of an `MDiagArray<T>` class, derived from the `DiagArray<T>` class. Then the `DiagMatrix` class will be derived from the `MDiagArray<T>` class.

Element by element MDiagArray by scalar ops.

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

Element by element scalar by MDiagArray ops.

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

Element by element MDiagArray by MDiagArray ops.

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

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

Unary MDiagArray ops.

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

4 Matrix and Vector Operations

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

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

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

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

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

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

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

Matrix transpose (void) const

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

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

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

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

ComplexMatrix fourier (void) const
ComplexMatrix ifourier (void) const

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

Matrix solve (const Matrix &*b*) const

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

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

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

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

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

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

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

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

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

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

Matrix operator ! (void) const

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

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

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

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

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

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

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

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

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

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

Matrix all (void) const
Matrix any (void) const

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

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

ColumnVector row_min (void) const
ColumnVector row_min_loc (void) const

ColumnVector row_max (void) const
ColumnVector row_max_loc (void) const

RowVector column_min (void) const
RowVector column_min_loc (void) const

RowVector column_max (void) const
RowVector column_max_loc (void) const

ostream& operator << (ostream &os, const Matrix &a)
```

```
istream& operator >> (istream &is, Matrix &a)

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

ColumnVector& operator = (const ColumnVector &a)

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

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

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

ColumnVector stack (const ColumnVector &a) const

RowVector transpose (void) const

ColumnVector extract (int r1, int r2) const

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

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

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

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

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

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

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

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

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

ColumnVector map (d_d_Mapper f, const ColumnVector &a)
void map (d_d_Mapper f)

double min (void) const
double max (void) const

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

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

RowVector& operator = (const RowVector &a)

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

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

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

RowVector append (const RowVector &a) const

ColumnVector transpose (void) const

RowVector extract (int c1, int c2) const

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

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

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

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

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

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

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

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

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

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

double min (void) const
double max (void) const

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

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

DiagMatrix& operator = (const DiagMatrix &a)

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

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

DiagMatrix transpose (void) const

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

ComplexMatrix (void)
ComplexMatrix (int r, int c)
ComplexMatrix (int r, int c, const Complex &val)
```

```
ComplexMatrix (const Matrix &a)
ComplexMatrix (const Array2<Complex> &a)
ComplexMatrix (const ComplexMatrix &a)
ComplexMatrix (const DiagMatrix &a)
ComplexMatrix (const DiagArray<Complex> &a)
ComplexMatrix (const ComplexDiagMatrix &a)

ComplexMatrix& operator = (const ComplexMatrix &a)

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

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

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

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

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

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

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

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

ComplexMatrix transpose (void) const

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

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

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

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

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

ComplexMatrix fourier (void) const
ComplexMatrix ifourier (void) const

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

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

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

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

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

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

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

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

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

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

Matrix operator ! (void) const
```

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

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

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

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

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

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

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

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

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

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

Matrix all (void) const
Matrix any (void) const

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

ComplexColumnVector diag (void) const
```

```
ComplexColumnVector diag (int k) const

ComplexColumnVector row_min (void) const
ComplexColumnVector row_min_loc (void) const

ComplexColumnVector row_max (void) const
ComplexColumnVector row_max_loc (void) const

ComplexRowVector column_min (void) const
ComplexRowVector column_min_loc (void) const

ComplexRowVector column_max (void) const
ComplexRowVector column_max_loc (void) const

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

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

ComplexColumnVector& operator = (const ComplexColumnVector &a)

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

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

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

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

ComplexRowVector transpose (void) const

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

ComplexColumnVector extract (int r1, int r2) const

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

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

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

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

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

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

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

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

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

Complex min (void) const
Complex max (void) const

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

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

ComplexRowVector& operator = (const ComplexRowVector &a)

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

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

ComplexRowVector& fill (double val)
```

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

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

ComplexColumnVector transpose (void) const

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

ComplexRowVector extract (int c1, int c2) const

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

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

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

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

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

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

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

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

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

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

Complex min (void) const
Complex max (void) const

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

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

ComplexDiagMatrix& operator = (const ComplexDiagMatrix &a)

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

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

ComplexDiagMatrix transpose (void) const

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

5 Matrix Factorizations

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

AEPBALANCE& operator = (const AEPBALANCE &a)

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

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

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

ComplexAEPBALANCE& operator = (const ComplexAEPBALANCE &a)

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

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

DET (void)
DET (const DET &a)

DET& operator = (const DET &a)

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

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

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

ComplexDET (void)
ComplexDET (const ComplexDET &a)

ComplexDET& operator = (const ComplexDET &a)

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

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

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

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

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

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

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

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

CHOL& operator = (const CHOL &a)

Matrix chol_matrix (void) const

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

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

ComplexCHOL& operator = (const ComplexCHOL &a)

ComplexMatrix chol_matrix (void) const

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

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

HESS& operator = (const HESS &a)

Matrix hess_matrix (void) const
Matrix unitary_hess_matrix (void) const

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

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

ComplexHESS& operator = (const ComplexHESS &a)

ComplexMatrix hess_matrix (void) const
ComplexMatrix unitary_hess_matrix (void) const

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

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

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

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

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

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

ComplexSCHUR& operator = (const ComplexSCHUR &a)

ComplexMatrix schur_matrix (void) const
ComplexMatrix unitary_matrix (void) const

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

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

SVD& operator = (const SVD &a)

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

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

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

ComplexSVD& operator = (const ComplexSVD &a)

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

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

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

EIG& operator = (const EIG &a)

ComplexColumnVector eigenvalues (void) const

ComplexMatrix eigenvectors (void) const

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

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

LU& operator = (const LU &a)

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

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

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

ComplexLU& operator = (const ComplexLU &a)

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

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

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

QR& operator = (const QR &a)

Matrix Q (void) const
Matrix R (void) const

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

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

ComplexQR& operator = (const ComplexQR &a)

ComplexMatrix Q (void) const
ComplexMatrix R (void) const

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

6 Ranges

FIXME: The `Range` class is obsolete.

7 Nonlinear Functions

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

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

nonlinear_fcn function (void) const;

NLFunc& set_function (const nonlinear_fcn *f*)

jacobian_fcn jacobian_function (void) const;

NLFunc& set_jacobian_function (const jacobian_fcn *j*)

8 Nonlinear Equations

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

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

void init (void)

void copy (const NLEqn_options &*opt*)

void set_default_options (void)

void set_tolerance (double *val*)

double tolerance (void)

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

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

void resize (int *n*)

void set_states (const ColumnVector &*x*)

ColumnVector states (void) const

int size (void) const

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

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

9 Optimization

9.1 Objective Functions

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

Objective& operator = (const Objective &a)

objective_fcn objective_function (void) const;

Objective& set_objective_function (const objective_fcn)

gradient_fcn gradient_function (void) const;

Objective& set_gradient_function (const gradient_fcn)
```

9.2 Bounds

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

Bounds& operator = (const Bounds &a)

Bounds& resize (int n)

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

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

int size (void) const;

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

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

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

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

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

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

9.3 Linear Constraints

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

LinConst& operator = (const LinConst &a)

LinConst& resize (int nclin, int n)

Matrix constraint_matrix (void) const;

LinConst& set_constraint_matrix (const Matrix &A)

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

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

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

9.4 Nonlinear Constraints

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

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

9.5 Quadratic Programming

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

virtual ColumnVector minimize (void)
```

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

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

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

9.6 Nonlinear Programming

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

NLP& operator = (const NLP &a)

int size (void) const

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

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

10 Quadrature

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

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

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

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

void init (void)

void copy (const Quad_options &*opt*)

void set_default_options (void)

void set_absolute_tolerance (double *val*)

void set_relative_tolerance (double *val*)

double absolute_tolerance (void)
double relative_tolerance (void)

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

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

10.1 Collocation Weights

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

```
CollocWt (int n, int inc_l, int inc_r, double l, double r)
CollocWt (const CollocWt&)

CollocWt& operator = (const CollocWt&)

CollocWt& resize (int ncol)

CollocWt& add_left (void)
CollocWt& add_right (void)

CollocWt& delete_left (void)
CollocWt& delete_right (void)

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

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

int ncol (void) const

int left_included (void) const
int right_included (void) const

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

double alpha (void) const
double beta (void) const

ColumnVector roots (void)
ColumnVector quad (void)
ColumnVector quad_weights (void)

Matrix first (void)
Matrix second (void)

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

11 Ordinary Differential Equations

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

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

void init (void)

void copy (const ODE_options &*opt*)

void set_default_options (void)

void set_absolute_tolerance (double *val*)

void set_initial_step_size (double *val*)

void set_maximum_step_size (double *val*)

void set_minimum_step_size (double *val*)

void set_relative_tolerance (double *val*)

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

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

virtual int size (void) const

virtual ColumnVector state (void) const

virtual double time (void) const

virtual void force_restart (void)

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

virtual void set_stop_time (double *t*)

virtual void clear_stop_time (void)

virtual ColumnVector integrate (double *t*)

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

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

12 Differential Algebraic Equations

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

ColumnVector deriv (void)

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

ColumnVector integrate (double t)

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

13 Error Handling

14 Installation

15 Bugs

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