

bml
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Chapter 1

Basic Matrix Library (bml)

This library implements a common API for linear algebra and matrix functions in C and Fortran. It offers several data structures for matrix storage and algorithms. Currently the following matrix data types are implemented:

- dense
- ellpack (sparse)
- csr (sparse)

1.1 Usage Examples

Usage examples can be found here:

- [Fortran Usage](#)
- [C Usage](#)

1.2 Modifying the library itself

If you are interested in modifying the library code itself, please have a look at the [Developer Documentation](#).

1.3 Planned Features

We are planning to eventually support different matrix types and matrix operations on a variety of hardware platforms. For details, please have a look at our [future plans](#).

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Chapter 2

Future Plans

2.1 Matrix Types

Support types:

- `bml_matrix_t`
- Colinear
- Noncolinear
- Blocked Bloch Matrix

2.2 Precisions

The bml supports the following precisions:

- logical (for matrix masks)
- single real
- double real
- single complex
- double complex

2.3 Functions

The library supports the following matrix operations:

- Format Conversion
 - `bml_convert::bml_convert_from_dense`
 - `bml_convert::bml_convert_to_dense`
 - `bml_convert::bml_convert`
- Masking
 - Masked operations (restricted to a subgraph)
- Addition

- $\alpha A + \beta B$: `bml_add::bml_add`
- $\alpha A + \beta$: `bml_add::bml_add_identity`
- Copy
 - $B \leftarrow A$: `bml_copy::bml_copy`
- Diagonalize
 - `bml_diagonalize::bml_diagonalize`
- Introspection
 - `bml_introspection::bml_get_type`
 - `bml_introspection::bml_get_size`
 - `bml_introspection::bml_get_bandwidth`
 - `bml_introspection::bml_get_spectral_range`
 - `bml_introspection::bml_get_HOMO_LUMO`
- Matrix manipulation:
 - `bml_get::bml_get`
 - `bml_get::bml_get_rows`
 - `bml_set::bml_set`
 - `bml_set::bml_set_rows`
- Multiplication
 - $\alpha A \times B + \beta C$: `bml_multiply::bml_multiply`
- Printing
 - `bml_utilities::bml_print_matrix`
- Scaling
 - $A \leftarrow \alpha A$: `bml_scale::bml_scale_one`
 - $B \leftarrow \alpha A$: `bml_scale::bml_scale_two`
- Matrix trace
 - $\text{Tr}[A]$: `bml_trace::bml_trace`
 - $\text{Tr}[AB]$: `bml_trace::bml_product_trace`
- Matrix norm
 - 2-norm
 - Frobenius norm
- Matrix transpose
 - `bml_transpose::bml_transpose`
- Matrix commutator/anticommutator
 - `bml_commutator::bml_commutator`
 - `bml_commutator::bml_anticommutator`

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Chapter 3

C Usage

In C, the following example code does the same as the above Fortran code:

```
#include <bml.h>

bml_matrix_t *A = bml_zero_matrix(dense,
    single_real, 100);
bml_deallocate(&A);
```

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Chapter 4

Fortran Usage

The use of this library is pretty straightforward. In the application code, use the bml main module,

```
use bml
```

A matrix is of type

```
type(bml_matrix_t) :: a
```

There are two important things to note. First, although not explicitly state in the above example, the matrix is not yet allocated. Hence, the matrix needs to be allocated through an allocation procedure with the desired type and precision, e.g. dense:double, see the page on [allocation functions](#) for a complete list. For instance,

```
call bml_zero_matrix(BML_MATRIX_DENSE, BML_PRECISION_DOUBLE, 100, a)
```

will allocate a dense, double-precision, 100×100 matrix which is initialized to zero. Additional functions allocate special matrices,

- [bml_allocate::bml_random_matrix](#) Allocate and initialize a random matrix.
- [bml_allocate::bml_identity_matrix](#) Allocate and initialize the identity matrix.

A matrix is deallocated by calling

```
call bml_deallocate(a)
```

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Chapter 5

Developer Documentation

5.1 Developer Suggested Workflow

We try to preserve a linear history in our main (master) branch. Instead of pulling (i.e. merging), we suggest you use:

```
$ git pull --rebase
```

And then

```
$ git push
```

To push your changes back to the server.

5.2 Coding Style

Please indent your C code using

```
$ indent -gnu -nut -i4 -bli0
```

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Chapter 6

Module Index

6.1 Modules

Here is a list of all modules:

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Chapter 7

Namespace Index

7.1 Namespace List

Here is a list of all documented namespaces with brief descriptions:

bml	Main matrix library module	29
bml_allocate	Matrix allocation functions	29
bml_interface	Interface module	29
bml_introspection	Introspection procedures	30
bml_types	The basic bml types	32
bml_utilities	Utility matrix functions	32

Chapter 8

Class Index

8.1 Class List

Here are the classes, structs, unions and interfaces with brief descriptions:

bml_introspection::bml_get_size_C	
Return the matrix size	35
bml_types::bml_matrix_t	
The bml matrix type	35

Chapter 9

File Index

9.1 File List

Here is a list of all documented files with brief descriptions:

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Chapter 10

Module Documentation

10.1 Allocation and Deallocation Functions (C interface)

Functions

- void * [bml_allocate_memory](#) (const size_t size)
- void [bml_free_memory](#) (void *ptr)
- void [bml_deallocate](#) ([bml_matrix_t](#) **A)
- [bml_matrix_t](#) * [bml_zero_matrix](#) (const [bml_matrix_type_t](#) matrix_type, const [bml_matrix_precision_t](#) matrix_precision, const int N, const int M)
- [bml_matrix_t](#) * [bml_random_matrix](#) (const [bml_matrix_type_t](#) matrix_type, const [bml_matrix_precision_t](#) matrix_precision, const int N, const int M)
- [bml_matrix_t](#) * [bml_identity_matrix](#) (const [bml_matrix_type_t](#) matrix_type, const [bml_matrix_precision_t](#) matrix_precision, const int N, const int M)

10.1.1 Detailed Description

10.1.2 Function Documentation

10.1.2.1 void* [bml_allocate_memory](#) (const size_t size)

Allocate and zero a chunk of memory.

Parameters

<i>size</i>	The size of the memory.
-------------	-------------------------

Returns

A pointer to the allocated chunk.

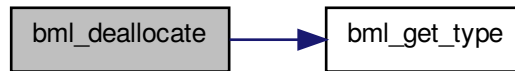
10.1.2.2 void [bml_deallocate](#) ([bml_matrix_t](#) ** A)

Deallocate a matrix.

Parameters

<i>A</i>	The matrix.
----------	-------------

Here is the call graph for this function:



10.1.2.3 void bml_free_memory (void * *ptr*)

Deallocate a chunk of memory.

Parameters

<i>ptr</i>	A pointer to the previously allocated chunk.
------------	--

10.1.2.4 bml_matrix_t* bml_identity_matrix (const bml_matrix_type_t *matrix_type*, const bml_matrix_precision_t *matrix_precision*, const int *N*, const int *M*)

Allocate the identity matrix.

Note that the matrix *A* will be newly allocated. The function does not check whether the matrix is already allocated.

Parameters

<i>matrix_type</i>	The matrix type.
<i>matrix_precision</i>	The precision of the matrix. The default is double precision.
<i>N</i>	The matrix size.
<i>M</i>	The number of non-zeroes per row.

Returns

The matrix.

10.1.2.5 bml_matrix_t* bml_random_matrix (const bml_matrix_type_t *matrix_type*, const bml_matrix_precision_t *matrix_precision*, const int *N*, const int *M*)

Allocate a random matrix.

Note that the matrix *A* will be newly allocated. The function does not check whether the matrix is already allocated.

Parameters

<i>matrix_type</i>	The matrix type.
<i>matrix_precision</i>	The precision of the matrix. The default is double precision.
<i>N</i>	The matrix size.

M	The number of non-zeroes per row.
-----	-----------------------------------

Returns

The matrix.

10.1.2.6 **bml_matrix_t*** `bml_zero_matrix (const bml_matrix_type_t matrix_type, const bml_matrix_precision_t matrix_precision, const int N, const int M)`

Allocate the zero matrix.

Note that the matrix A will be newly allocated. The function does not check whether the matrix is already allocated.

Parameters

<i>matrix_type</i>	The matrix type.
<i>matrix_precision</i>	The precision of the matrix. The default is double precision.
N	The matrix size.
M	The number of non-zeroes per row.

Returns

The matrix.

10.2 Converting between Matrix Formats (C interface)

Functions

- `bml_matrix_t * bml_convert_from_dense` (const `bml_matrix_type_t` *matrix_type*, const `bml_matrix_precision_t` *matrix_precision*, const int *N*, const void **A*, const double *threshold*, const int *M*)
- void * `bml_convert_to_dense` (const `bml_matrix_t` **A*)

10.2.1 Detailed Description

10.2.2 Function Documentation

10.2.2.1 `bml_matrix_t* bml_convert_from_dense (const bml_matrix_type_t matrix_type, const bml_matrix_precision_t matrix_precision, const int N, const void * A, const double threshold, const int M)`

Convert a dense matrix into a bml matrix.

Parameters

<i>matrix_type</i>	The matrix type
<i>matrix_precision</i>	The real precision
<i>N</i>	The number of rows/columns
<i>A</i>	The dense matrix
<i>threshold</i>	The matrix element magnited threshold
<i>M</i>	The number of non-zeroes per row

Returns

The bml matrix

10.2.2.2 `void* bml_convert_to_dense (const bml_matrix_t * A)`

Convert a bml matrix into a dense matrix.

The returned pointer has to be typecase into the proper real type. If the bml matrix is a single precision matrix, then the following should be used:

```
float *A_dense = bml_convert_to_dense(A_bml);
```

The matrix size can be queried with

```
int N = bml_get_size(A_bml);
```

Parameters

<i>A</i>	The bml matrix
----------	----------------

Returns

The dense matrix

Here is the call graph for this function:



10.3 Allocation and Deallocation Functions (Fortran interface)

Functions

- subroutine, public `bml_allocate::bml_deallocate` (*a*)
Deallocate a matrix.
- subroutine, public `bml_allocate::bml_zero_matrix` (*matrix_type*, *matrix_precision*, *n*, *a*, *m*)
Create the zero matrix.
- subroutine, public `bml_allocate::bml_random_matrix` (*matrix_type*, *matrix_precision*, *n*, *a*, *m*)
Create a random matrix.
- subroutine, public `bml_allocate::bml_identity_matrix` (*matrix_type*, *matrix_precision*, *n*, *a*, *m*)
Create the identity matrix.

10.3.1 Detailed Description

10.3.2 Function Documentation

10.3.2.1 subroutine, public `bml_allocate::bml_deallocate` (*type(bml_matrix_t) a*)

Deallocate a matrix.

Parameters

<i>a</i>	The matrix.
----------	-------------

10.3.2.2 subroutine, public `bml_allocate::bml_identity_matrix` (*character(len=*)*, *intent(in) matrix_type*, *character(len=*)*, *intent(in) matrix_precision*, *integer*, *intent(in) n*, *type(bml_matrix_t)*, *intent(inout) a*, *integer*, *intent(in) m*)

Create the identity matrix.

Parameters

<i>matrix_type</i>	The matrix type.
<i>matrix_precision</i>	The precision of the matrix.
<i>n</i>	The matrix size.
<i>a</i>	The matrix.
<i>m</i>	The extra arg.

10.3.2.3 subroutine, public `bml_allocate::bml_random_matrix` (*character(len=*)*, *intent(in) matrix_type*, *character(len=*)*, *intent(in) matrix_precision*, *integer*, *intent(in) n*, *type(bml_matrix_t)*, *intent(inout) a*, *integer*, *intent(in) m*)

Create a random matrix.

Parameters

<i>matrix_type</i>	The matrix type.
<i>matrix_precision</i>	The precision of the matrix.
<i>n</i>	The matrix size.
<i>a</i>	The matrix.
<i>m</i>	The extra arg.

10.3.2.4 subroutine, public bml_allocate::bml_zero_matrix (character(len=*), intent(in) *matrix_type*, character(len=*), intent(in) *matrix_precision*, integer, intent(in) *n*, type(bml_matrix_t), intent(inout) *a*, integer, intent(in) *m*)

Create the zero matrix.

Parameters

<i>matrix_type</i>	The matrix type.
<i>matrix_precision</i>	The precision of the matrix.
<i>n</i>	The matrix size.
<i>a</i>	The matrix.
<i>m</i>	The extra arg.

10.4 Converting between Matrix Formats (Fortran interface)

Functions

- subroutine `bml_convert::bml_convert_from_dense_double` (`matrix_type`, `matrix_precision`, `a_dense`, `a`, `threshold`, `m`)
Convert a dense matrix into a bml matrix.
- subroutine `bml_convert::bml_convert_to_dense_single` (`a`, `a_dense`)
Convert a matrix into a dense matrix.
- subroutine `bml_convert::bml_convert_to_dense_double` (`a`, `a_dense`)
Convert a matrix into a dense matrix.

10.4.1 Detailed Description

10.4.2 Function Documentation

- 10.4.2.1 subroutine `bml_convert::bml_convert_from_dense_double` (`character(len=*)`, `intent(in)` `matrix_type`, `character(len=*)`, `intent(in)` `matrix_precision`, `double precision`, `dimension(:, :)`, `intent(in)`, `target` `a_dense`, `type(bml_matrix_t)`, `intent(inout)` `a`, `double precision`, `intent(in)` `threshold`, `integer`, `intent(in)` `m`)

Convert a dense matrix into a bml matrix.

Parameters

<code>matrix_type</code>	The matrix type
<code>matrix_precision</code>	The matrix precision
<code>a_dense</code>	The dense matrix
<code>a</code>	The bml matrix
<code>threshold</code>	The matrix element magnited threshold
<code>m</code>	the extra arg

- 10.4.2.2 subroutine `bml_convert::bml_convert_to_dense_double` (`type(bml_matrix_t)`, `intent(in)` `a`, `double precision`, `dimension(:, :)`, `intent(out)`, `pointer` `a_dense`)

Convert a matrix into a dense matrix.

Parameters

<code>a</code>	The bml matrix
<code>a_dense</code>	The dense matrix

- 10.4.2.3 subroutine `bml_convert::bml_convert_to_dense_single` (`type(bml_matrix_t)`, `intent(in)` `a`, `real`, `dimension(:, :)`, `intent(out)`, `pointer` `a_dense`)

Convert a matrix into a dense matrix.

Parameters

<code>a</code>	The bml matrix
<code>a_dense</code>	The dense matrix

Chapter 11

Namespace Documentation

11.1 bml Module Reference

Main matrix library module.

11.1.1 Detailed Description

Main matrix library module.

Use this modules in order to use the library.

11.2 bml_allocate Module Reference

Matrix allocation functions.

Functions/Subroutines

- subroutine, public [bml_deallocate](#) (a)
Deallocate a matrix.
- subroutine, public [bml_zero_matrix](#) (matrix_type, matrix_precision, n, a, m)
Create the zero matrix.
- subroutine, public [bml_random_matrix](#) (matrix_type, matrix_precision, n, a, m)
Create a random matrix.
- subroutine, public [bml_identity_matrix](#) (matrix_type, matrix_precision, n, a, m)
Create the identity matrix.

11.2.1 Detailed Description

Matrix allocation functions.

11.3 bml_interface Module Reference

Interface module.

Functions/Subroutines

- integer function, public [get_enum_id](#) (type_string)
Convert the matrix type and precisions strings into enum values.

Variables

- integer, parameter [bml_matrix_type_uninitialized_enum_id](#) = 0
The enum values of the C API. Keep this synchronized with the enum in [bml_types.h](#).
- integer, parameter [bml_matrix_type_dense_enum_id](#) = 1
- integer, parameter [bml_matrix_precision_single_enum_id](#) = 0
- integer, parameter [bml_matrix_precision_double_enum_id](#) = 1

11.3.1 Detailed Description

Interface module.

11.3.2 Function/Subroutine Documentation

11.3.2.1 integer function, public [bml_interface::get_enum_id](#) (character(len=*) , intent(in) type_string)

Convert the matrix type and precisions strings into enum values.

Parameters

type_string	The string used in the Fortran API to identify the matrix type and precision.
-----------------------------	---

Returns

The corresponding integer value matching the enum values in [bml_matrix_types_t](#) and [bml_matrix_precision_t](#).

11.4 bml_introspection Module Reference

Introspection procedures.

Data Types

- interface [bml_get_size_C](#)
Return the matrix size.

Functions/Subroutines

- integer function [bml_get_size](#) (a)
Return the matrix size.

11.4.1 Detailed Description

Introspection procedures.

11.4.2 Function/Subroutine Documentation

11.4.2.1 integer function `bml_introspection::bml_get_size (type(bml_matrix_t), intent(in) a)`

Return the matrix size.

Parameters

<i>a</i>	The matrix.
----------	-------------

Returns

The matrix size.

11.5 bml_types Module Reference

The basic bml types.

Data Types

- type [bml_matrix_t](#)
The bml matrix type.

Variables

- character(len=*), parameter [bml_matrix_dense](#) = "dense"
The bml-dense matrix type identifier.
- character(len=*), parameter [bml_matrix_ellpack](#) = "ellpack"
The bml-ellpack matrix type identifier.
- character(len=*), parameter [bml_precision_single](#) = "single-precision"
The single precision identifier.
- character(len=*), parameter [bml_precision_double](#) = "double-precision"
The double-precision identifier.

11.5.1 Detailed Description

The basic bml types.

11.6 bml_utilities Module Reference

Utility matrix functions.

Functions/Subroutines

- subroutine [bml_print_matrix_double](#) (tag, a, i_l, i_u, j_l, j_u)
Print a dense matrix.

11.6.1 Detailed Description

Utility matrix functions.

11.6.2 Function/Subroutine Documentation

11.6.2.1 subroutine `bml_utilities::bml_print_matrix_double` (character(len=*) *tag*, double precision, dimension(:, :),
intent(in), target *a*, integer, intent(in) *i_l*, integer, intent(in) *i_u*, integer, intent(in) *j_l*, integer, intent(in) *j_u*)

Print a dense matrix.

Parameters

<i>tag</i>	A string to print before the matrix.
<i>a</i>	The matrix.
<i>i_l</i>	The lower row bound.
<i>i_u</i>	The upper row bound.
<i>j_l</i>	The lower column bound.
<i>j_u</i>	The upper column bound.

Chapter 12

Class Documentation

12.1 `bml_introspection::bml_get_size_C` Interface Reference

Return the matrix size.

Public Member Functions

- `integer(c_int)` function **`bml_get_size_c`** (a)

12.1.1 Detailed Description

Return the matrix size.

The documentation for this interface was generated from the following file:

- `/home/nbock/Work/bml/src-new/Fortran-interface/bml_introspection.F90`

12.2 `bml_types::bml_matrix_t` Type Reference

The bml matrix type.

Public Attributes

- `type(c_ptr)` `ptr` = `C_NULL_PTR`
The C pointer to the matrix.

12.2.1 Detailed Description

The bml matrix type.

The documentation for this type was generated from the following file:

- `/home/nbock/Work/bml/src-new/Fortran-interface/bml_types.F90`

Chapter 13

File Documentation

13.1 /home/nbock/Work/bml/src-new/C-interface/blas.h File Reference

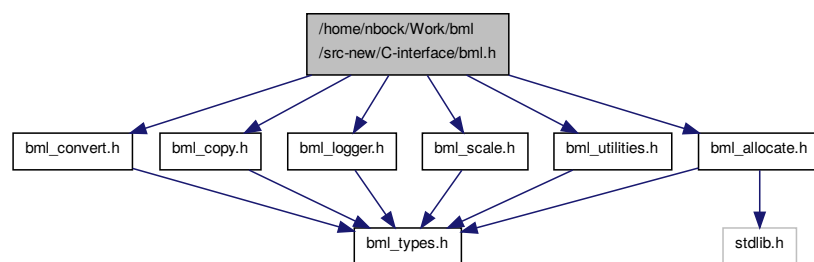
Functions

- void **C_SSCAL** (const int *n, const float *a, float *x, const int *incx)
- void **C_DSCAL** (const int *n, const double *a, double *x, const int *incx)

13.2 /home/nbock/Work/bml/src-new/C-interface/bml.h File Reference

```
#include "bml_allocate.h"  
#include "bml_convert.h"  
#include "bml_copy.h"  
#include "bml_logger.h"  
#include "bml_scale.h"  
#include "bml_utilities.h"
```

Include dependency graph for bml.h:



13.2.1 Detailed Description

Copyright

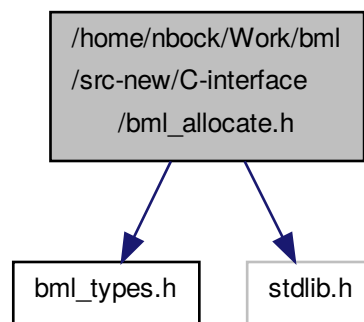
Los Alamos National Laboratory 2015

13.3 /home/nbock/Work/bml/src-new/C-interface/bml_allocate.h File Reference

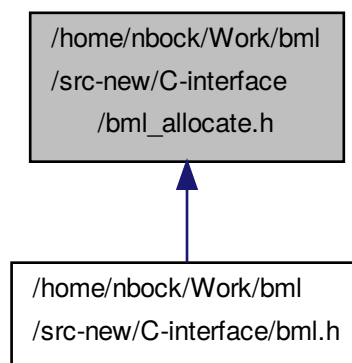
```
#include "bml_types.h"
```

```
#include <stdlib.h>
```

Include dependency graph for bml_allocate.h:



This graph shows which files directly or indirectly include this file:



Functions

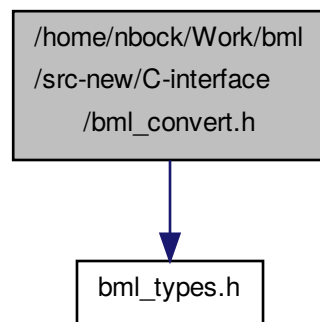
- void * [bml_allocate_memory](#) (const size_t s)
- void [bml_free_memory](#) (void *ptr)
- void [bml_deallocate](#) ([bml_matrix_t](#) **A)

- `bml_matrix_t * bml_zero_matrix` (const `bml_matrix_type_t` matrix_type, const `bml_matrix_precision_t` matrix_precision, const int N, const int M)
- `bml_matrix_t * bml_random_matrix` (const `bml_matrix_type_t` matrix_type, const `bml_matrix_precision_t` matrix_precision, const int N, const int M)
- `bml_matrix_t * bml_identity_matrix` (const `bml_matrix_type_t` matrix_type, const `bml_matrix_precision_t` matrix_precision, const int N, const int M)

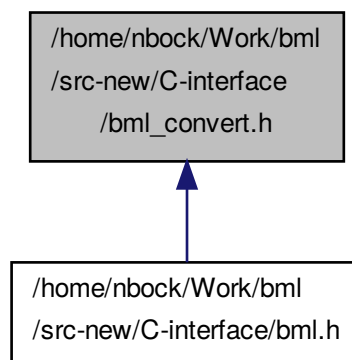
13.4 /home/nbock/Work/bml/src-new/C-interface/bml_convert.h File Reference

```
#include "bml_types.h"
```

Include dependency graph for bml_convert.h:



This graph shows which files directly or indirectly include this file:



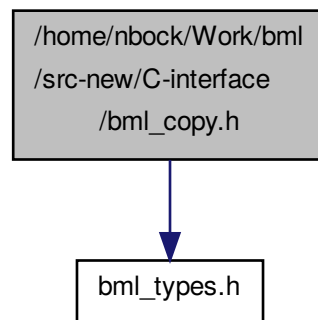
Functions

- `bml_matrix_t * bml_convert_from_dense` (const `bml_matrix_type_t` matrix_type, const `bml_matrix_precision_t` matrix_precision, const int N, const void *A, const double threshold, const int M)
- void * `bml_convert_to_dense` (const `bml_matrix_t` *A)

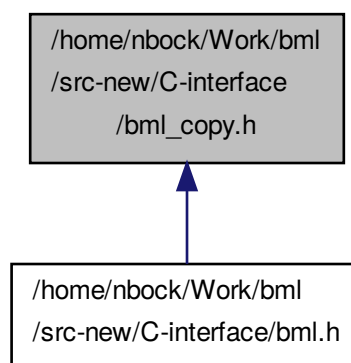
13.5 /home/nbock/Work/bml/src-new/C-interface/bml_copy.h File Reference

```
#include "bml_types.h"
```

Include dependency graph for bml_copy.h:



This graph shows which files directly or indirectly include this file:



Functions

- `bml_matrix_t * bml_copy_new` (const `bml_matrix_t` *A)
- void `bml_copy` (const `bml_matrix_t` *A, const `bml_matrix_t` *B)

13.5.1 Function Documentation

13.5.1.1 void bml_copy (const bml_matrix_t * *A*, const bml_matrix_t * *B*)

Copy a matrix.

Parameters

<i>A</i>	Matrix to copy
<i>B</i>	Copy of Matrix A

Here is the call graph for this function:



13.5.1.2 bml_matrix_t* bml_copy_new (const bml_matrix_t * *A*)

Copy a matrix - result is a new matrix.

Parameters

<i>A</i>	Matrix to copy
----------	----------------

Returns

A Copy of A

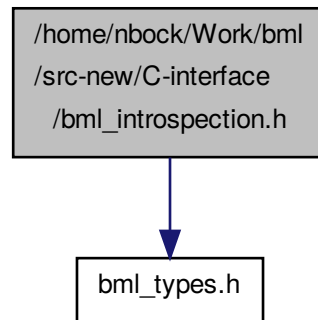
Here is the call graph for this function:



13.6 /home/nbock/Work/bml/src-new/C-interface/bml_introspection.h File Reference

```
#include "bml_types.h"
```

Include dependency graph for bml_introspection.h:



Functions

- [bml_matrix_type_t bml_get_type](#) (const [bml_matrix_t](#) *A)
- int [bml_get_size](#) (const [bml_matrix_t](#) *A)

13.6.1 Function Documentation

13.6.1.1 int bml_get_size (const bml_matrix_t * A)

Return the matrix size.

Parameters

<i>A</i>	The matrix.
----------	-------------

Returns

The matrix size.

Here is the call graph for this function:



13.6.1.2 `bml_matrix_type_t bml_get_type (const bml_matrix_t * A)`

Returns the matrix type.

If the matrix is not initialized yet, a type of "uninitialized" is returned.

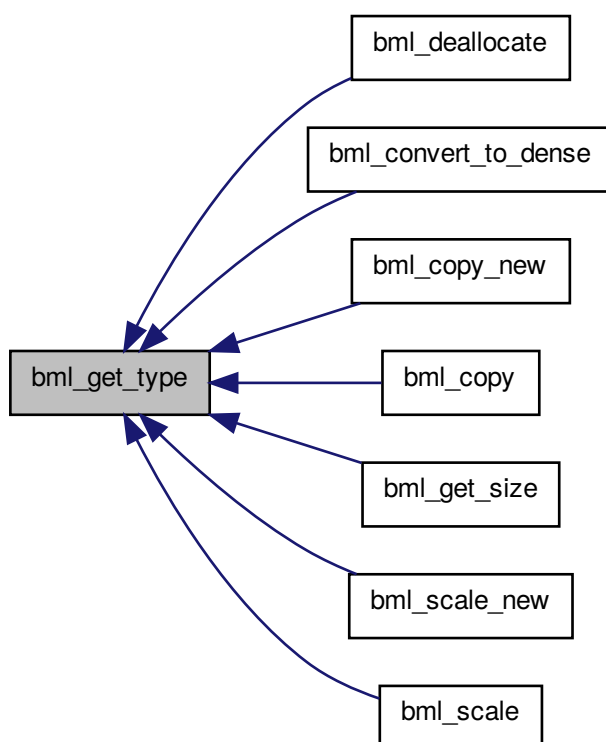
Parameters

<code>A</code>	The matrix.
----------------	-------------

Returns

The matrix type.

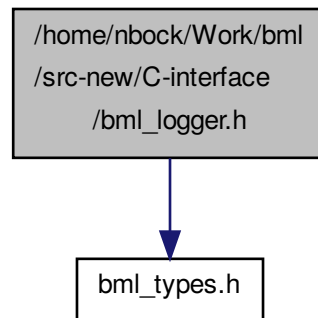
Here is the caller graph for this function:



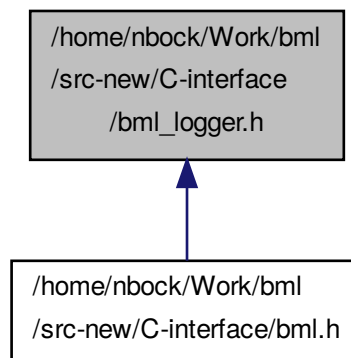
13.7 /home/nbock/Work/bml/src-new/C-interface/bml_logger.h File Reference

```
#include "bml_types.h"
```

Include dependency graph for bml_logger.h:



This graph shows which files directly or indirectly include this file:



Macros

- `#define LOG_DEBUG(format, ...) bml_log_location(BML_LOG_DEBUG, __FILE__, __LINE__, format, ##__VA_ARGS__)`
- `#define LOG_INFO(format, ...) bml_log(BML_LOG_INFO, format, ##__VA_ARGS__)`
- `#define LOG_WARN(format, ...) bml_log_location(BML_LOG_WARNING, __FILE__, __LINE__, format, ##__VA_ARGS__)`
- `#define LOG_ERROR(format, ...) bml_log_location(BML_LOG_ERROR, __FILE__, __LINE__, format, ##__VA_ARGS__)`

Enumerations

- enum `bml_log_level_t` { `BML_LOG_DEBUG`, `BML_LOG_INFO`, `BML_LOG_WARNING`, `BML_LOG_ERROR` }

Functions

- void [bml_log](#) (const [bml_log_level_t](#) log_level, const char *format,...)
- void [bml_log_location](#) (const [bml_log_level_t](#) log_level, const char *filename, const int linenumber, const char *format,...)

13.7.1 Macro Definition Documentation

13.7.1.1 `#define LOG_DEBUG(format, ...) bml_log_location(BML_LOG_DEBUG, __FILE__, __LINE__, format, ##__VA_ARGS__)`

Convenience macro to write a BML_LOG_DEBUG level message.

13.7.1.2 `#define LOG_ERROR(format, ...) bml_log_location(BML_LOG_ERROR, __FILE__, __LINE__, format, ##__VA_ARGS__)`

Convenience macro to write a BML_LOG_ERROR level message.

13.7.1.3 `#define LOG_INFO(format, ...) bml_log(BML_LOG_INFO, format, ##__VA_ARGS__)`

Convenience macro to write a BML_LOG_INFO level message.

13.7.1.4 `#define LOG_WARN(format, ...) bml_log_location(BML_LOG_WARNING, __FILE__, __LINE__, format, ##__VA_ARGS__)`

Convenience macro to write a BML_LOG_WARNING level message.

13.7.2 Enumeration Type Documentation

13.7.2.1 `enum bml_log_level_t`

The log-levels.

Enumerator

BML_LOG_DEBUG Debugging messages.

BML_LOG_INFO Info messages.

BML_LOG_WARNING Warning messages.

BML_LOG_ERROR Error messages.

13.7.3 Function Documentation

13.7.3.1 `void bml_log (const bml_log_level_t log_level, const char * format, ...)`

Log a message.

Parameters

<i>log_level</i>	The log level.
------------------	----------------

<i>format</i>	The format (as in printf()).
---------------	------------------------------

13.7.3.2 void bml_log_location (const bml_log_level_t *log_level*, const char * *filename*, const int *linenumber*, const char * *format*, ...)

Log a message with location, i.e. filename and linenumber..

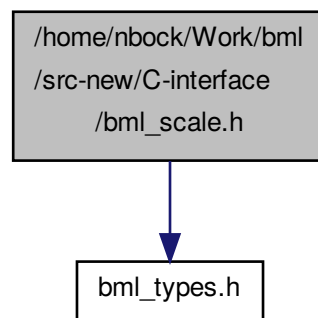
Parameters

<i>log_level</i>	The log level.
<i>filename</i>	The filename to log.
<i>linenumber</i>	The linenumber.
<i>format</i>	The format (as in printf()).

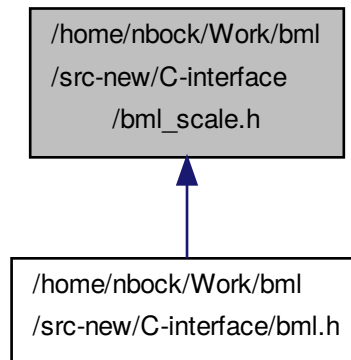
13.8 /home/nbock/Work/bml/src-new/C-interface/bml_scale.h File Reference

```
#include "bml_types.h"
```

Include dependency graph for bml_scale.h:



This graph shows which files directly or indirectly include this file:



Functions

- `bml_matrix_t * bml_scale_new` (const double *scale_factor*, const `bml_matrix_t` **A*)
- void `bml_scale` (const double *scale_factor*, const `bml_matrix_t` **A*, const `bml_matrix_t` **B*)

13.8.1 Function Documentation

13.8.1.1 void `bml_scale` (const double *scale_factor*, const `bml_matrix_t` * *A*, const `bml_matrix_t` * *B*)

Scale a matrix - resulting matrix exists.

Parameters

<i>scale_factor</i>	Scale factor for A
<i>A</i>	Matrix to scale
<i>B</i>	Scaled Matrix

Here is the call graph for this function:



13.8.1.2 `bml_matrix_t * bml_scale_new` (const double *scale_factor*, const `bml_matrix_t` * *A*)

Scale a matrix - resulting matrix is new.

Parameters

<i>scale_factor</i>	Scale factor for A
<i>A</i>	Matrix to scale

Returns

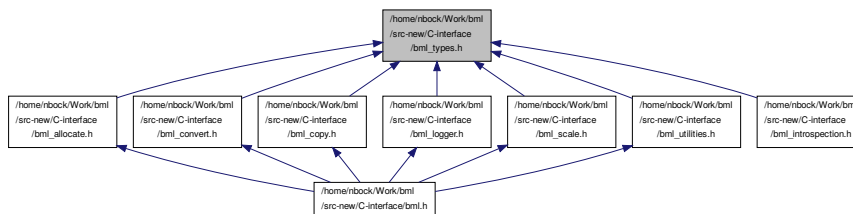
A Scaled Copy of A

Here is the call graph for this function:



13.9 /home/nbock/Work/bml/src-new/C-interface/bml_types.h File Reference

This graph shows which files directly or indirectly include this file:



Typedefs

- typedef void [bml_matrix_t](#)

Enumerations

- enum [bml_matrix_type_t](#) { uninitialized, dense, ellpack, csr }
- enum [bml_matrix_precision_t](#) { single_real, double_real }

13.9.1 Typedef Documentation

13.9.1.1 typedef void bml_matrix_t

The matrix type.

13.9.2 Enumeration Type Documentation

13.9.2.1 enum bml_matrix_precision_t

The supported real precisions.

Enumerator

single_real Matrix data is stored in single precision (float).

double_real Matrix data is stored in double precision (double).

13.9.2.2 enum bml_matrix_type_t

The supported matrix types.

Enumerator

uninitialized The matrix is not initialized.

dense Dense matrix.

ellpack ELLPACK matrix.

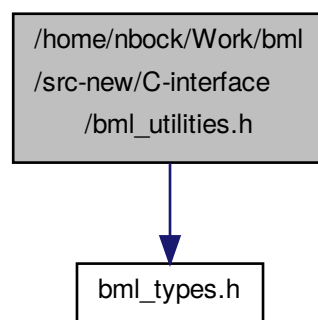
csr CSR matrix.

13.10 /home/nbock/Work/bml/src-new/C-interface/bml_types_private.h File Reference

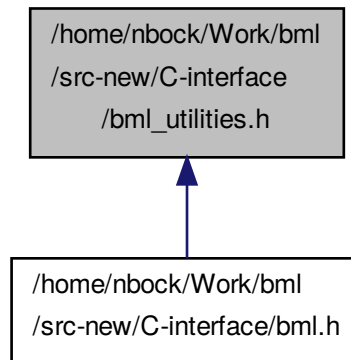
13.11 /home/nbock/Work/bml/src-new/C-interface/bml_utilities.h File Reference

```
#include "bml_types.h"
```

Include dependency graph for bml_utilities.h:



This graph shows which files directly or indirectly include this file:



Functions

- void [bml_print_matrix](#) (const int *N*, [bml_matrix_precision_t](#) *matrix_precision*, const void **A*, const int *i_l*, const int *i_u*, const int *j_l*, const int *j_u*)

13.11.1 Function Documentation

13.11.1.1 void [bml_print_matrix](#) (const int *N*, [bml_matrix_precision_t](#) *matrix_precision*, const void * *A*, const int *i_l*, const int *i_u*, const int *j_l*, const int *j_u*)

Print a dense matrix.

Parameters

<i>N</i>	The number of rows/columns.
<i>matrix_precision</i>	The real precision.
<i>A</i>	The matrix.
<i>i_l</i>	The lower row index.
<i>i_u</i>	The upper row index.
<i>j_l</i>	The lower column index.
<i>j_u</i>	The upper column index.

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