FINEL

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Contents

Chapter 1

Modules Index

1.1 Modules List

Here is a list of all modules with brief descriptions:

Chapter 2

Data Type Index

2.1 Data Types List

Here are the data types with brief descriptions:

Chapter 3

File Index

3.1 File List

Here is a list of all files with brief descriptions:

Chapter 4

Module Documentation

4.1 meshstructure Module Reference

Module that contains the data structure of a mesh associate to a problem.

Data Types

- type mesh

  Data type for a mesh.

Functions/Subroutines

- subroutine mallocnodes (meshStrct, n)

  Routine that allocate memory to node data.
- subroutine mallocelem (meshStrct, n)

  Routine that allocate memory to element data.

4.1.1 Detailed Description

Module that contains the data structure of a mesh associate to a problem.

Author

Diego T. Volpatto

4.1.2 Function/Subroutine Documentation

4.1.2.1 mallocelem()

```
subroutine meshstructure::mallocelem (
             type(mesh) meshStrct,
             integer n )
```

Routine that allocate memory to element data.

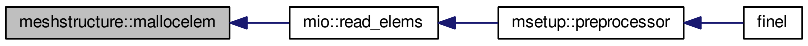
Parameters

meshStrct	[in/out] mesh structure to allocate
n	[in] number of elements

Author

Diego T. Volpatto

Here is the caller graph for this function:



4.1.2.2 mallocnodes()

```
subroutine meshstructure::mallocnodes (
             type(mesh) meshStrct,
             integer n )
```

Routine that allocate memory to node data.

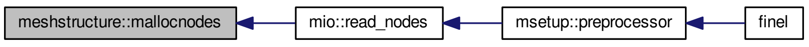
Parameters

meshStrct	[in/out] mesh structure to allocate
n	[in] number of nodes

Author

Diego T. Volpatto

Here is the caller graph for this function:



4.2 minputreader Module Reference

Modulo responsavel por reunir subrotinas para leitura do arquivo de entrada.

Functions/Subroutines

- subroutine readinputfileds ()

  Le arquivo de input e armazena seu conteudo em um array.
- subroutine createsimpleinputfile ()

  Cria a estrutura de input usando um arquivo de entrada sem includes.
- subroutine mergeincludecontents (include_file, include_line)

  Le o conteudo do arquivo de include e armazena no array principal.
- subroutine preparefilelines (include_indexes, include_number_of_lines, number_of_includes, original_file_↩ lines)

  Efetua a alocacao da estrutura definitiva, preparando a linha dos arquivos originais para receber os includes.
- subroutine analyzefileinput (number_of_lines, number_of_includes)

  Efetua algumas analises no arquivo recebido.
- subroutine analyzefile (file_name, number_of_lines, number_of_includes)

  Efetua algumas analises no arquivo recebido.
- integer $*4$ function findinclude (position, file_lines, number_of_lines)

  Procura a n-esima palavra-chave include.
- integer $*4$ function findkeyword (keyword)

  Procura uma palavra-chave.
- subroutine readintegerkeywordvalue (keyword, target, default_value)

  Efetua a leitura de uma palavra-chave to tipo inteiro. Se nao encontrado, associa o valor default fornecido.
- subroutine readintarraykeywordvalue (keyword, target, default_value)

  Efetua a leitura de uma palavra-chave do tipo array de inteiro. Se nao encontrado, associa o valor default fornecido. Obs.: Atentar para o fato dessa sub-rotina ter um do "infinito".
- subroutine readstringkeywordvalue (keyword, target, default_value)

  Efetua a leitura de uma palavra-chave to tipo string. Se nao encontrado, associa o valor default fornecido.
- subroutine readrealkeywordvalue (keyword, target, default_value)

  Efetua a leitura de uma palavra-chave to tipo real. Se nao encontrado, associa o valor default fornecido.
- subroutine readrealmatrixvalues (keyword, target, default_value)

  Efetua a leitura de uma palavra-chave do tipo de um array bidimensional real. A leitura eh realizada linha por linha. Se nao encontrado, associa o valor default fornecido.
- subroutine readboundaryconditions (keyword, kbc, vbc, default_value)

  Efetua a leitura de uma palavra-chave do tipo de um array bidimensional real. A leitura eh realizada linha por linha. Se nao encontrado, associa o valor default fornecido.

Variables

- character(len=200), dimension(:), allocatable file_lines

  Armazena as linhas do arquivo de input.
- integer $*4$ number_of_lines

  Armazena o numero de linhas no arquivo.

4.2.1 Detailed Description

Modulo responsavel por reunir subrotinas para leitura do arquivo de entrada.

4.2.2 Function/Subroutine Documentation

4.2.2.1 analyzefile()

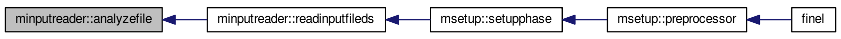
```
subroutine minputreader::analyzefile (
             character(len=200) file_name,
             integer*4 number_of_lines,
             integer*4 number_of_includes )
```

Efetua algumas analises no arquivo recebido.

Parameters

file_name	O nome do arquivo.
number_of_lines	Numero de linhas.
number_of_include	Numero de ocorrencias da palavra include.

Here is the caller graph for this function:



4.2.2.2 analyzefileinput()

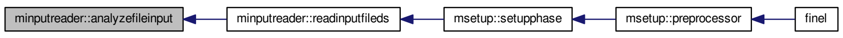
```
subroutine minputreader::analyzefileinput (
             integer*4 number_of_lines,
             integer*4 number_of_includes )
```

Efetua algumas analises no arquivo recebido.

Parameters

number_of_lines	Numero de linhas.
number_of_include	Numero de ocorrencias da palavra include.

Here is the caller graph for this function:



4.2.2.3 createsimpleinputfile()

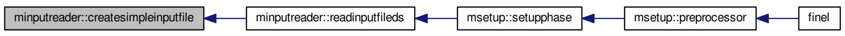
```
subroutine minputreader::createsimpleinputfile ( )
```

Cria a estrutura de input usando um arquivo de entrada sem includes.

Parameters

file_name	Nome do arquivo a ser lido.

Here is the caller graph for this function:


minputreader::createsimpleinputfile
minputreader::readinputfileds
msetup::setupphase
msetup::preprocessor
finel

4.2.2.4 findinclude()

```
integer*4 function minputreader::findinclude (
            integer*4 position,
            character(len=200), dimension(:)  file_lines,
            integer*4 number_of_lines )
```

Procura a n-esima palavra-chave include.

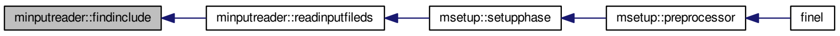
Parameters

position	Corresponde a posicao desejada.
file_lines	Linhas do arquivo.
number_of_lines	Numero de linhas atuais.

Returns

O indice da palavra-chave no array que contem as linhas do arquivo de entrada.

Here is the caller graph for this function:



4.2.2.5 findkeyword()

```
integer*4 function minputreader::findkeyword (
            character(50) keyword )
```

Procura uma palavra-chave.

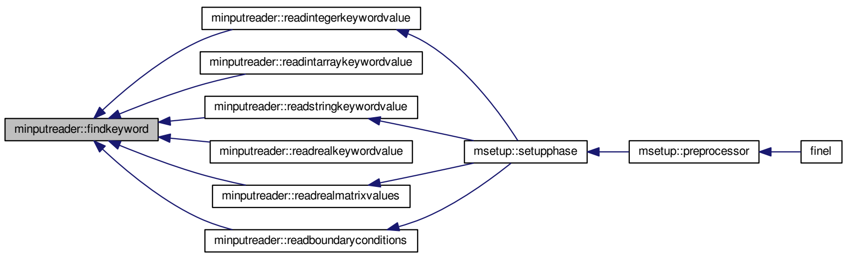
Parameters

keyword	A palavra-chave.

Returns

O indice da palavra-chave no array que contem as linhas do arquivo de entrada.

Here is the caller graph for this function:


minputreader::readintegerkeywordvalue
minputreader::readintarraykeywordvalue
minputreader::readstringkeywordvalue
minputreader::findkeyword
minputreader::readrealkeywordvalue
msetup::setupphase
msetup::preprocessor
finel
minputreader::readrealmatrixvalues
minputreader::readboundaryconditions

4.2.2.6 mergeincludecontents()

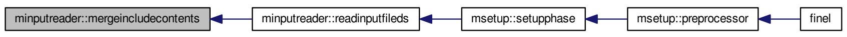
```
subroutine minputreader::mergeincludecontents (
             character(len=200) include_file,
             integer*4 include_line )
```

Le o conteudo do arquivo de include e armazena no array principal.

Parameters

include_index	O index do include.
include_files	Array com includes.
include_line	A linha do include.

Here is the caller graph for this function:


minputreader::mergeincludecontents
minputreader::readinputfileds
msetup::setupphase
msetup::preprocessor
finel

4.2.2.7 preparefilelines()

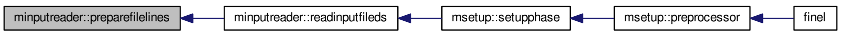
```
subroutine minputreader::preparefilelines (
             integer*4, dimension(:)  include_indexes,
             integer*4, dimension(:)  include_number_of_lines,
             integer*4 number_of_includes,
             character(len=200), dimension(:)  original_file_lines )
```

Efetua a alocacao da estrutura definitiva, preparando a linha dos arquivos originais para receber os includes.

Parameters

include_indexes	Array os indices de ocorrencias dos includes.
include_number_of_lines	Array com o numero de linhas de cada include
number_of_includes	Numero de includes.
original_file_lines	Linhas do arquivo de entrada original.

Here is the caller graph for this function:



4.2.2.8 readboundaryconditions()

```
subroutine minputreader::readboundaryconditions (
             character(50) keyword,
             integer*4, dimension(:), allocatable kbc,
             real*8, dimension(:), allocatable vbc,
             real(8) default_value )
```

Efetua a leitura de uma palavra-chave do tipo de um array bidimensional real. A leitura eh realizada linha por linha. Se nao encontrado, associa o valor default fornecido.

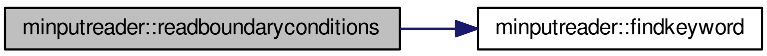
Parameters

keyword	A palavra-chave a ser encontrada.
kbc	Tipo da CC (1 = Dirichlet, 2 = Neumann).
vbc	Valor prescrito na CC.
default_value	Valor default.

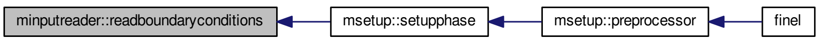
Author

Diego T. Volpatto

Here is the call graph for this function:


minputreader::readboundaryconditions
minputreader::findkeyword

Here is the caller graph for this function:



4.2.2.9 readinputfileds()

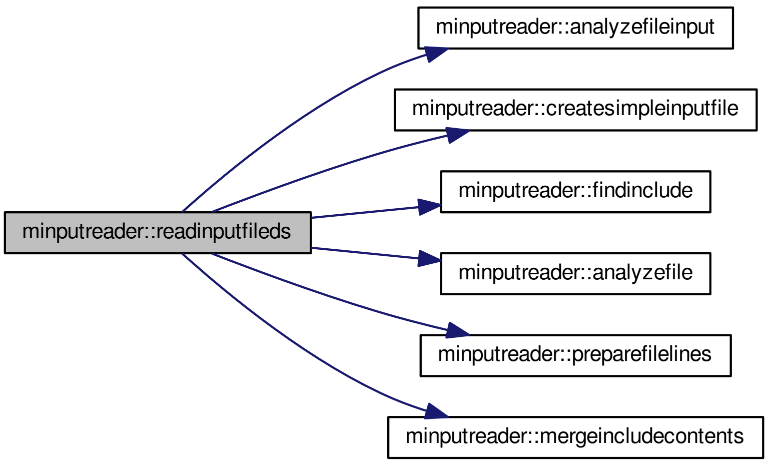
```
subroutine minputreader::readinputfileds ( )
```

Le arquivo de input e armazena seu conteudo em um array.

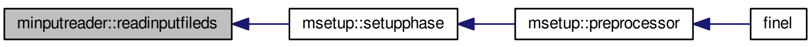
Parameters

file_name	Nome do arquivo a ser lido.

Here is the call graph for this function:


minputreader::readinputfileds
minputreader::analyzefileinput
minputreader::createsimpleinputfile
minputreader::findinclude
minputreader::analyzefile
minputreader::preparefilelines
minputreader::mergeincludecontents

Here is the caller graph for this function:



4.2.2.10 readintarraykeywordvalue()

```
subroutine minputreader::readintarraykeywordvalue (
             character(50) keyword,
             integer*4, dimension(:), allocatable target,
             integer*4 default_value )
```

Efetua a leitura de uma palavra-chave do tipo array de inteiro. Se nao encontrado, associa o valor default fornecido. Obs.: Atentar para o fato dessa sub-rotina ter um do "infinito".

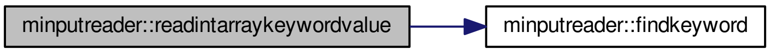
Parameters

keyword	A palavra-chave a ser encontrada.
target	Variavel onde o valor inteiro sera atribuido.
default_value	Valor default.

Author

Diego Volpatto

Here is the call graph for this function:


minputreader::readintarraykeywordvalue
minputreader::findkeyword

4.2.2.11 readintegerkeywordvalue()

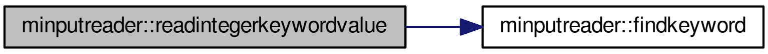
```
subroutine minputreader::readintegerkeywordvalue (
             character(50) keyword,
              target,
             integer*4, target default_value )
```

Efetua a leitura de uma palavra-chave to tipo inteiro. Se nao encontrado, associa o valor default fornecido.

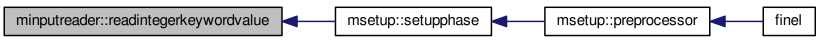
Parameters

keyword	A palavra-chave a ser encontrada.
target	Variavel onde o valor inteiro sera atribuido.
default_value	Valor default.

Here is the call graph for this function:


minputreader::readintegerkeywordvalue
minputreader::findkeyword

Here is the caller graph for this function:



4.2.2.12 readrealkeywordvalue()

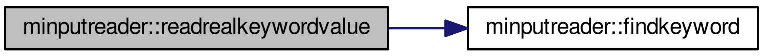
```
subroutine minputreader::readrealkeywordvalue (
            character(50) keyword,
             target,
            real(8), target default_value )
```

Efetua a leitura de uma palavra-chave to tipo real. Se nao encontrado, associa o valor default fornecido.

Parameters

keyword	A palavra-chave a ser encontrada.
target	Variavel onde o real sera atribuido.
default_value	Valor default.

Here is the call graph for this function:



4.2.2.13 readrealmatrixvalues()

```
subroutine minputreader::readrealmatrixvalues (
            character(50) keyword,
            real*8, dimension(:,:), allocatable target,
            real(8) default_value )
```

Efetua a leitura de uma palavra-chave do tipo de um array bidimensional real. A leitura eh realizada linha por linha. Se nao encontrado, associa o valor default fornecido.

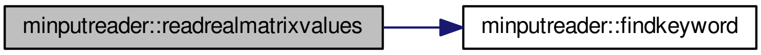
Parameters

keyword	A palavra-chave a ser encontrada.
target	Variavel onde os valores serao atribuido.
default_value	Valor default.

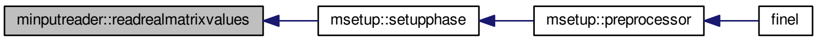
Author

Diego T. Volpatto

Here is the call graph for this function:



Here is the caller graph for this function:



4.2.2.14 readstringkeywordvalue()

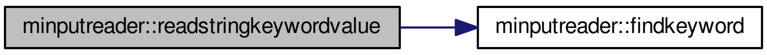
```
subroutine minputreader::readstringkeywordvalue (
            character(50) keyword,
            character(len=*) target,
            character(len=*) default_value )
```

Efetua a leitura de uma palavra-chave to tipo string. Se nao encontrado, associa o valor default fornecido.

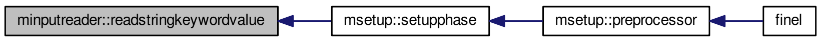
Parameters

keyword	A palavra-chave a ser encontrada.
target	Variavel onde a string sera atribuido.
default_value	Valor default.

Here is the call graph for this function:


minputreader::readstringkeywordvalue
minputreader::findkeyword

Here is the caller graph for this function:



4.2.3 Variable Documentation

4.2.3.1 file_lines

```
character(len=200), dimension(:), allocatable minputreader::file_lines
```

Armazena as linhas do arquivo de input.

4.2.3.2 number_of_lines

```
integer*4 minputreader::number_of_lines
```

Armazena o numero de linhas no arquivo.

4.3 mio Module Reference

Functions/Subroutines

- subroutine openfiles ()

  Open IO files.
- subroutine closefiles ()

  Close IO files.
- subroutine read_nodes (mesh_)

  Subroutine to read node data file generated by EasyMesh.
- subroutine read_elems (mesh_)

  Subroutine to read element data file generated by EasyMesh.
- subroutine print_sol1d (mesh_, scalar_)

Variables

- integer, parameter iin = 111

  Input file id.
- integer, parameter iout = 112

  Output file id.
- integer, parameter isol = 113

  Solution file id.
- character(len=20), parameter infile ='input.dat'

  Input file name.
- character(len=20), parameter outfile ='output.dat'

  Output file name.
- character(len=20), parameter solfile ='solution.dat'

  Solution file name.
- character(len=50) title

4.3.1 Function/Subroutine Documentation

4.3.1.1 closefiles()

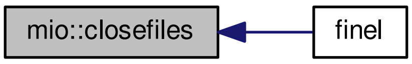
```
subroutine mio::closefiles ( )
```

Close IO files.

Author

Diego T. Volpatto

Here is the caller graph for this function:



4.3.1.2 openfiles()

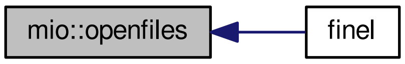
```
subroutine mio::openfiles ( )
```

Open IO files.

Author

Diego T. Volpatto

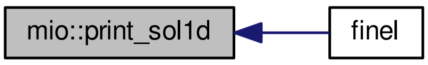
Here is the caller graph for this function:



4.3.1.3 print_sol1d()

```
subroutine mio::print_sol1d (
            type(mesh) mesh_,
            type(scalarstructuresystem) scalar_ )
```

Here is the caller graph for this function:



4.3.1.4 read_elems()

```
subroutine mio::read_elems (
            type(mesh) mesh_ )
```

Subroutine to read element data file generated by EasyMesh.

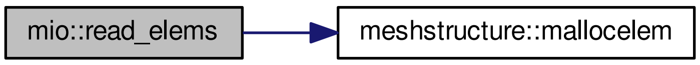
Parameters

mesh←_	[in/out] a mesh structure

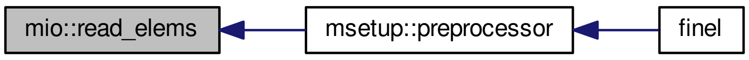
Author

Diego Volpatto

Here is the call graph for this function:



Here is the caller graph for this function:



4.3.1.5 read_nodes()

```
subroutine mio::read_nodes (
             type(mesh) mesh_ )
```

Subroutine to read node data file generated by EasyMesh.

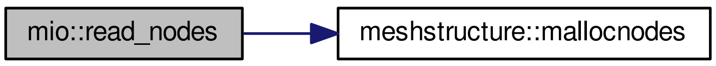
Parameters

mesh← _	[in/out] a mesh structure

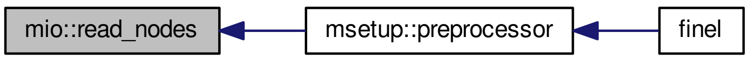
Author

Diego Volpatto

Here is the call graph for this function:



Here is the caller graph for this function:



4.3.2 Variable Documentation

4.3.2.1 iin

```
integer, parameter mio::iin = 111
```

Input file id.

4.3.2.2 infile

```
character(len=20), parameter mio::infile ='input.dat'
```

Input file name.

4.3.2.3 iout

```
integer, parameter mio::iout = 112
```

Output file id.

4.3.2.4 isol

```
integer, parameter mio::isol = 113
```

Solution file id.

4.3.2.5 outfile

```
character(len=20), parameter mio::outfile ='output.dat'
```

Output file name.

4.3.2.6 solfile

```
character(len=20), parameter mio::solfile ='solution.dat'
```

Solution file name.

4.3.2.7 title

```
character(len=50) mio::title
```

4.4 mprocessor Module Reference

Processor module to compute, assemble and solve the system.

Functions/Subroutines

- subroutine formkf (mesh_, scalar_)

    Form and assemble Ku = F system.
- subroutine assmb (mesh_, scalar_, nel)

    Assemble element stiffness matrix and load vector to global stiffness matrix and load vector, respectively.
- subroutine drchlt (mesh_, scalar_, n)

    Apply Dirichlet Boundary Condition.
- subroutine neumann1d (mesh_, scalar_, n)

    Apply Neumann Boundary Condition – 1D. Prescribe -k(x)u = vbc.
- subroutine applybc (mesh_, scalar_)

    Modify Ku=F system to incorporate BC data.
- subroutine solver (mesh_, scalar_)
- subroutine processor (mesh_, scalar_)

    Processor routine phase.

4.4.1 Detailed Description

Processor module to compute, assemble and solve the system.

Author

Diego T. Volpatto

4.4.2 Function/Subroutine Documentation

4.4.2.1 applybc()

```
subroutine mprocessor::applybc (
            type(mesh) mesh_,
            type(scalarstructuresystem) scalar_ )
```

Modify Ku=F system to incorporate BC data.

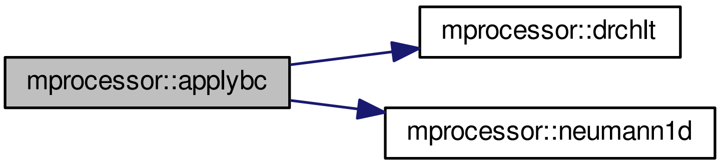
Parameters

mesh↩ _	A mesh structure
scalar↩ _	A scalar structure

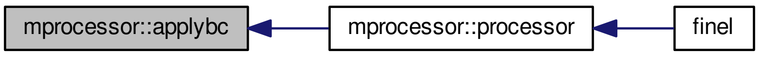
Author

Diego Volpatto

Here is the call graph for this function:



Here is the caller graph for this function:



4.4.2.2 assmb()

```
subroutine mprocessor::assmb (
             type(mesh) mesh_,
             type(scalarstructuresystem) scalar_,
             integer nel )
```

Assemble element stiffness matrix and load vector to global stiffness matrix and load vector, respectively.

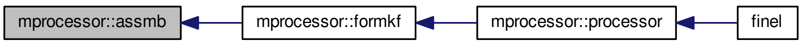
Parameters

mesh←↩ _	A mesh structure
scalar←↩ _	A scalar structure
nel	Index of current element

Author

Diego Volpatto

Here is the caller graph for this function:



4.4.2.3 drchlt()

```
subroutine mprocessor::drchlt (
             type(mesh) mesh_,
             type(scalarstructuresystem) scalar_,
             integer n )
```

Apply Dirichlet Boundary Condition.

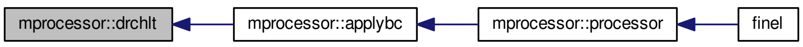
Parameters

mesh↩_	A mesh structure
scalar↩_	A scalar structure
n	Node index of BC

Author

Diego Volpatto

Here is the caller graph for this function:



4.4.2.4 formkf()

```
subroutine mprocessor::formkf (
             type(mesh) mesh_,
             type(scalarstructuresystem) scalar_ )
```

Form and assemble Ku = F system.

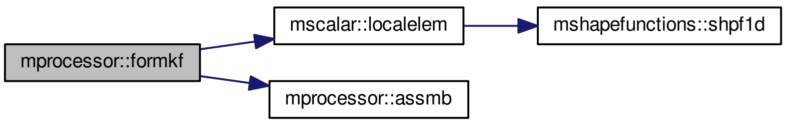
Parameters

mesh←_	[in/out] A mesh structure
scalar←_	[in/out] A scalar structure

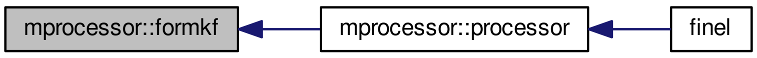
Author

Diego Volpatto

Here is the call graph for this function:



Here is the caller graph for this function:



4.4.2.5 neumann1d()

```
subroutine mprocessor::neumann1d (
            type(mesh) mesh_,
            type(scalarstructuresystem) scalar_,
            integer n )
```

Apply Neumann Boundary Condition – 1D. Prescribe -k(x)u = vbc.

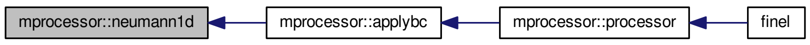
Parameters

mesh←_	A mesh structure
scalar←_	A scalar structure
n	Node index of BC

Author

Diego Volpatto

Here is the caller graph for this function:



4.4.2.6 processor()

```
subroutine mprocessor::processor (
             type(mesh) mesh_,
             type(scalarstructuresystem) scalar_ )
```

Processor routine phase.

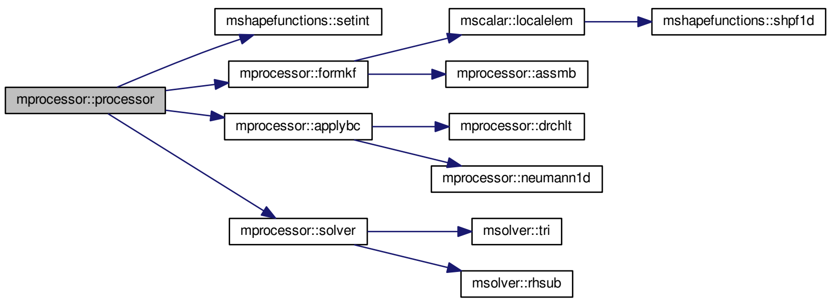
Parameters

mesh←↩ _	A mesh structure
scalar←↩ _	A scalar structure

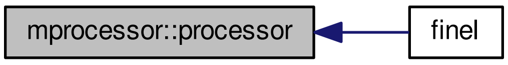
Author

Diego T. Volpatto

Here is the call graph for this function:



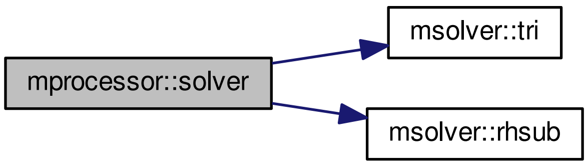
Here is the caller graph for this function:



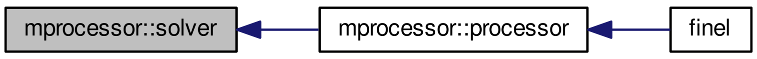
4.4.2.7 solver()

```
subroutine mprocessor::solver (
            type(mesh) mesh_,
            type(scalarstructuresystem) scalar_ )
```

Here is the call graph for this function:



Here is the caller graph for this function:



4.5 mscalar Module Reference

Contains variables and subroutine related to a general scalar problem.

Functions/Subroutines

- subroutine localelem (mesh_, scalar_, nel)
  Computes a master element contribution – 1D.

4.5.1 Detailed Description

Contains variables and subroutine related to a general scalar problem.

Author

Diego T. Volpatto

4.5.2 Function/Subroutine Documentation

4.5.2.1 localelem()

```
subroutine mscalar::localelem (
            type(mesh) mesh_,
            type(scalarstructuresystem) scalar_,
            integer nel )
```

Computes a master element contribution – 1D.

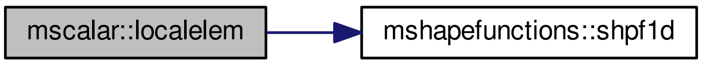
Parameters

*mesh_*	[in/out] A mesh structure
*scalar_*	[in/out] A scalar structure
nel	[in] Index of current element

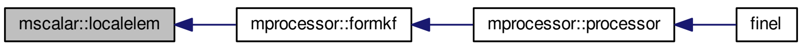
Author

Diego Volpatto

Here is the call graph for this function:



Here is the caller graph for this function:



4.6 msetup Module Reference

Module for setup phase by IO procedures.

Functions/Subroutines

- subroutine setupphase (mesh_, scalar_)
- subroutine preprocessor (mesh_, scalar_)

  Realizes preprocessor routines.

4.6.1 Detailed Description

Module for setup phase by IO procedures.

Author

Diego T. Volpatto

4.6.2 Function/Subroutine Documentation

4.6.2.1 preprocessor()

```
subroutine msetup::preprocessor (
             type(mesh) mesh_,
             type(scalarstructuresystem) scalar_ )
```

Realizes preprocessor routines.

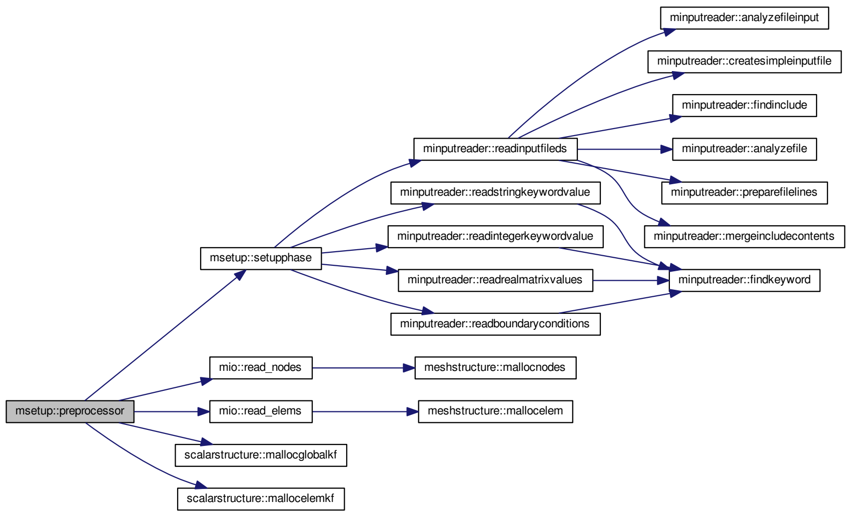
Parameters

mesh↩ _	A mesh structure
scalar↩ _	A scalar structure

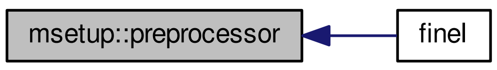
Author

Diego T. Volpatto

Here is the call graph for this function:


minputreader::analyzefileinput
minputreader::createsimpleinputfile
minputreader::findinclude
minputreader::readinputfileds
minputreader::analyzefile
minputreader::readstringkeywordvalue
minputreader::preparefilelines
minputreader::readintegerkeywordvalue
minputreader::mergeincludecontents
msetup::setupphase
minputreader::readrealmatrixvalues
minputreader::findkeyword
minputreader::readboundaryconditions
mio::read_nodes
meshstructure::mallocnodes
msetup::preprocessor
mio::read_elems
meshstructure::mallocelem
scalarstructure::mallocglobalkf
scalarstructure::mallocelemkf

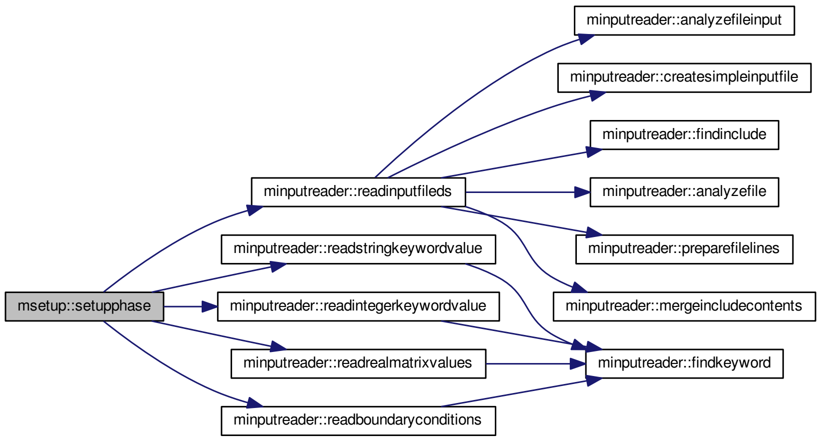
Here is the caller graph for this function:



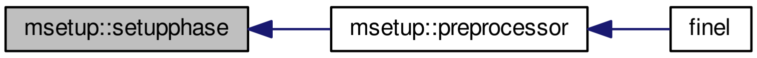
4.6.2.2 setupphase()

```
subroutine msetup::setupphase (
            type(mesh) mesh_,
            type(scalarstructuresystem) scalar_ )
```

Here is the call graph for this function:


minputreader::analyzefileinput
minputreader::createsimpleinputfile
minputreader::findinclude
minputreader::readinputfileds
minputreader::analyzefile
minputreader::readstringkeywordvalue
minputreader::preparefilelines
msetup::setupphase
minputreader::readintegerkeywordvalue
minputreader::mergeincludecontents
minputreader::readrealmatrixvalues
minputreader::findkeyword
minputreader::readboundaryconditions

Here is the caller graph for this function:



4.7 mshapefunctions Module Reference

Module for shape functions computations and relate operations.

Functions/Subroutines

- subroutine setint

  Gauss quadrature data set routine.
- subroutine shpf1d (xl, n, psi, dpsi)

  Calculates the values of the shape functions and their derivatives.

Variables

- real ∗8, dimension(4, 4) xi

  Gauss point integration.
- real ∗8, dimension(4, 4) w

  Gauss weights.

4.7.1 Detailed Description

Module for shape functions computations and relate operations.

Author

Diego T. Volpatto

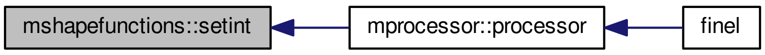
4.7.2 Function/Subroutine Documentation

4.7.2.1 setint()

```
subroutine mshapefunctions::setint ( )
```

Gauss quadrature data set routine.

Here is the caller graph for this function:



4.7.2.2 shpf1d()

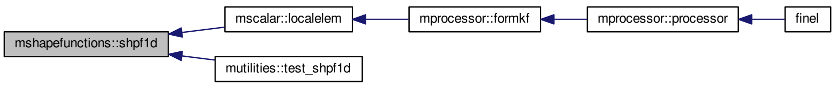
```
subroutine mshapefunctions::shpf1d (
             real*8 xl,
             integer n,
             real*8, dimension(n) psi,
             real*8, dimension(n) dpsi )
```

Calculates the values of the shape functions and their derivatives.

Parameters

xl	[in] specified value of master element coord
n	[in] number of element nodes
psi	[out] shape function values
dpsi	[out] derivatives shape functions values

Here is the caller graph for this function:



4.7.3 Variable Documentation

4.7.3.1 w

```
real*8, dimension(4,4) mshapefunctions::w
```

Gauss weights.

4.7.3.2 xi

```
real*8, dimension(4,4) mshapefunctions::xi
```

Gauss point integration.

4.8 msolver Module Reference

Contains subroutine to compute numerical solution of linear systems Ax=b.

Functions/Subroutines

- subroutine tri (A, n)

  Applies Gauss reduction in A(n,n) to obtain a superior triangular equivalent form.
- subroutine rhsub (A, x, b, n)

  Does the forward substitution on the right-side-hand.

4.8.1 Detailed Description

Contains subroutine to compute numerical solution of linear systems Ax=b.

The present module has a general purpose such that the routines here intend to be independent of others module.

Author

Diego T. Volpatto

4.8.2 Function/Subroutine Documentation

4.8.2.1 rhsub()

```
subroutine msolver::rhsub (
              real*8, dimension(n,n) A,
              real*8, dimension(n) x,
              real*8, dimension(n) b,
              integer n )
```

Does the forward substitution on the right-side-hand.

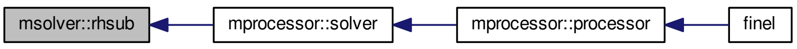
Parameters

A	[in]A matrix A(n,n)
x	[out]Solution vector
b	[in/out]RHS-vector
n	[in]Number of solution points

Author

Diego T. Volpatto

Here is the caller graph for this function:



4.8.2.2 tri()

```
subroutine msolver::tri (
             real*8, dimension(n,n) A,
             integer n )
```

Applies Gauss reduction in A(n,n) to obtain a superior triangular equivalent form.

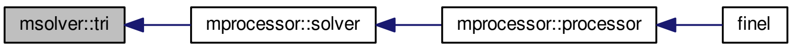
Parameters

A	[in/out]A matrix A(n,n)
n	[in]Number of rows/columns of matrix A

Author

Diego T. Volpatto

Here is the caller graph for this function:



4.9 mutilities Module Reference

Module for auxiliar routines.

Functions/Subroutines

- subroutine linspace (x1, x2, nintv, x)

  Generate points between x1 and x2 equally spaced in x(i). Same idea of numpy subroutine.
- real ∗8 function f1 (x)

  A function to test purpose.
- subroutine quad1 (n, x1, x2)

  Subroutine that computes gaussian quadrature of f1.
- subroutine test_shpf1d (n, nelem, x)

  Check if shpf1d works properly.
- subroutine print_matrix (A, n, m)

  Prints in the screen a matrix A(n,m)

4.9.1 Detailed Description

Module for auxiliar routines.

Author

Diego T. Volpatto

4.9.2 Function/Subroutine Documentation

4.9.2.1 f1()

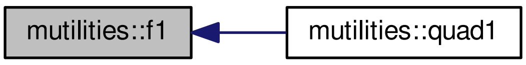
```
real*8 function mutilities::f1 (
            real*8 x )
```

A function to test purpose.

Parameters

x	input coordinate

Here is the caller graph for this function:



4.9.2.2 linspace()

```
subroutine mutilities::linspace (
            real*8 x1,
            real*8 x2,
            integer nintv,
            real*8, dimension(:), allocatable x )
```

Generate points between x1 and x2 equally spaced in x(i). Same idea of numpy subroutine.

Parameters

x1	interval lower bound
x2	interval upper bound
nintv	num of intervals
x	vector to assemble the values

4.9.2.3 print_matrix()

```
subroutine mutilities::print_matrix (
            real*8, dimension(n,m) A,
            integer n,
            integer m )
```

Prints in the screen a matrix A(n,m)

Parameters

A	A matrix
n	Number of lines of A
m	Number of colunms of A

Author

Diego Volpatto

4.9.2.4 quad1()

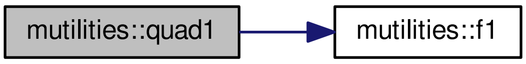
```
subroutine mutilities::quad1 (
            integer n,
            real*8 x1,
            real*8 x2 )
```

Subroutine that computes gaussian quadrature of f1.

Parameters

n	quadrature order
x1	integral lower bound
x2	integral upper bound

Here is the call graph for this function:



4.9.2.5 test_shpf1d()

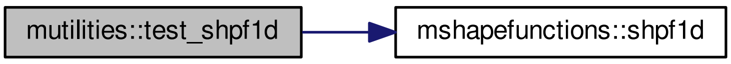
```
subroutine mutilities::test_shpf1d (
             integer n,
             integer nelem,
             real*8, dimension(nelem+1) x )
```

Check if shpf1d works properly.

Parameters

n	element node numbers
nelem	num of discrete intervals
x	master element's coordinates

Here is the call graph for this function:



4.10 scalarstructure Module Reference

Module that contains the data structure of a general scalar problem.

Data Types

- type scalarstructuresystem

    Variables and characteristic data for a scalar problem.

Functions/Subroutines

- subroutine mallocglobalkf (scalar_, n)

  Routine to allocate and clear the Ku = F system.
- subroutine mallocelemkf (scalar_, n)

  Routine to allocate and clear the element KF.

4.10.1 Detailed Description

Module that contains the data structure of a general scalar problem.

Author

Diego T. Volpatto

4.10.2 Function/Subroutine Documentation

4.10.2.1 mallocelemkf()

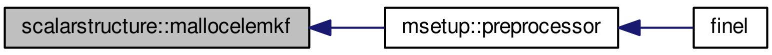
```
subroutine scalarstructure::mallocelemkf (
             type(scalarstructuresystem) scalar_,
             integer n )
```

Routine to allocate and clear the element KF.

Parameters

*scalar_*	[in/out] A general scalar structure
n	[in] Number of element nodes

Here is the caller graph for this function:



4.10.2.2 mallocglobalkf()

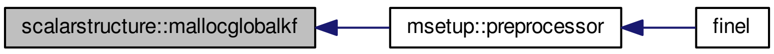
```
subroutine scalarstructure::mallocglobalkf (
             type(scalarstructuresystem) scalar_,
             integer n )
```

Routine to allocate and clear the Ku = F system.

Parameters

*scalar_*	[in/out] A general scalar structure
n	[in] Number of global nodes

Here is the caller graph for this function:



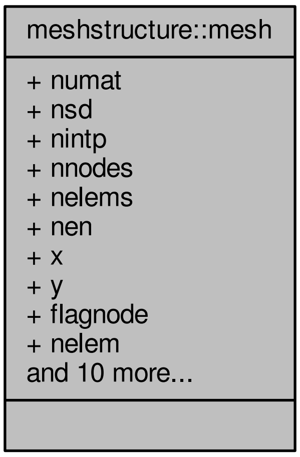
Chapter 5

Data Type Documentation

5.1 meshstructure::mesh Type Reference

Data type for a mesh.

Collaboration diagram for meshstructure::mesh:



Public Attributes

- integer numat

    Number of materials.
- integer nsd

    Number of spatial.
- integer nintp

    Number of integration points.

- integer nnodes

  Number of nodes.
- integer nelems

  Number of elements.
- integer nen

  Number of element's nodes.
- real ∗8, dimension(:), allocatable x

  x coordinates nodes
- real ∗8, dimension(:), allocatable y

  y coordinates nodes
- integer ∗4, dimension(:), allocatable flagnode

  boundary flag
- integer nelem

  Number of elements.
- real ∗8, dimension(:), allocatable xv

  Circumcenter Elem xcoor.
- real ∗8, dimension(:), allocatable yv

  Circumcenter Elem ycoor.
- integer ∗4, dimension(:,:), allocatable gnode

  Global node.
- integer ∗4, dimension(:), allocatable mat

  Element material kind.
- integer ∗4, dimension(:), allocatable ei

  i-opposite element
- integer ∗4, dimension(:), allocatable ej

  j-opposite element
- integer ∗4, dimension(:), allocatable ek

  k-opposite element
- integer ∗4, dimension(:), allocatable si

  Opposite i-side.
- integer ∗4, dimension(:), allocatable sj

  Opposite j-side.
- integer ∗4, dimension(:), allocatable sk

  Opposite k-side.

5.1.1 Detailed Description

Data type for a mesh.

5.1.2 Member Data Documentation

5.1.2.1 ei

```
integer*4, dimension(:), allocatable meshstructure::mesh::ei
```

i-opposite element

5.1.2.2 ej

```
integer*4, dimension(:), allocatable meshstructure::mesh::ej
```

j-opposite element

5.1.2.3 ek

```
integer*4, dimension(:), allocatable meshstructure::mesh::ek
```

k-opposite element

5.1.2.4 flagnode

```
integer*4, dimension(:), allocatable meshstructure::mesh::flagnode
```

boundary flag

5.1.2.5 gnode

```
integer*4, dimension(:,:), allocatable meshstructure::mesh::gnode
```

Global node.

5.1.2.6 mat

```
integer*4, dimension(:), allocatable meshstructure::mesh::mat
```

Element material kind.

5.1.2.7 nelem

```
integer meshstructure::mesh::nelem
```

Number of elements.

5.1.2.8 nelems

```
integer meshstructure::mesh::nelems
```

Number of elements.

5.1.2.9 nen

```
integer meshstructure::mesh::nen
```

Number of element's nodes.

5.1.2.10 nintp

```
integer meshstructure::mesh::nintp
```

Number of integration points.

5.1.2.11 nnodes

```
integer meshstructure::mesh::nnodes
```

Number of nodes.

5.1.2.12 nsd

```
integer meshstructure::mesh::nsd
```

Number of spatial.

5.1.2.13 numat

```
integer meshstructure::mesh::numat
```

Number of materials.

5.1.2.14 si

```
integer*4, dimension(:), allocatable meshstructure::mesh::si
```

Opposite i-side.

5.1.2.15 sj

```
integer*4, dimension(:), allocatable meshstructure::mesh::sj
```

Opposite j-side.

5.1.2.16 sk

```
integer*4, dimension(:), allocatable meshstructure::mesh::sk
```

Opposite k-side.

5.1.2.17 x

```
real*8, dimension(:), allocatable meshstructure::mesh::x
```

x coordinates nodes

5.1.2.18 xv

```
real*8, dimension(:), allocatable meshstructure::mesh::xv
```

Circumcenter Elem xcoor.

5.1.2.19 y

```
real*8, dimension(:), allocatable meshstructure::mesh::y
```

y coordinates nodes

5.1.2.20 yv

```
real*8, dimension(:), allocatable meshstructure::mesh::yv
```

Circumcenter Elem ycoor.

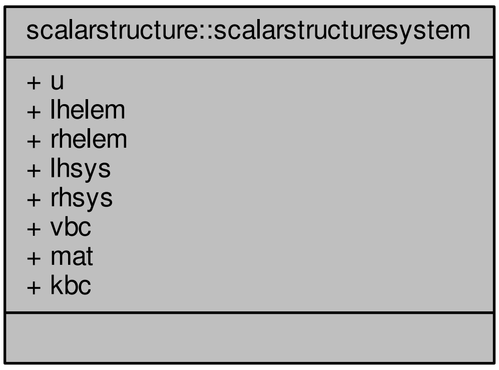
The documentation for this type was generated from the following file:

- src/meshStructure.F90

5.2 scalarstructure::scalarstructuresystem Type Reference

Variables and characteristic data for a scalar problem.

Collaboration diagram for scalarstructure::scalarstructuresystem:



Public Attributes

- real ∗8, dimension(:), allocatable u

    Solution vector.
- real ∗8, dimension(:,:), allocatable lhelem

    Element left-hand system.
- real ∗8, dimension(:), allocatable rhelem

    Element right-hand system.
- real ∗8, dimension(:,:), allocatable lhsys

    Global left-hand system.
- real ∗8, dimension(:), allocatable rhsys

    Global right-hand system.
- real ∗8, dimension(:), allocatable vbc

    BC values vector.
- real ∗8, dimension(:,:), allocatable mat

    Material properties values.
- integer ∗4, dimension(:), allocatable kbc

    BC kind.

5.2.1 Detailed Description

Variables and characteristic data for a scalar problem.

5.2.2 Member Data Documentation

5.2.2.1 kbc

```
integer*4, dimension(:), allocatable scalarstructure::scalarstructuresystem::kbc
```

BC kind.

5.2.2.2 lhelem

```
real*8, dimension(:,:), allocatable scalarstructure::scalarstructuresystem::lhelem
```

Element left-hand system.

5.2.2.3 lhsys

```
real*8, dimension(:,:), allocatable scalarstructure::scalarstructuresystem::lhsys
```

Global left-hand system.

5.2.2.4 mat

```
real*8, dimension(:,:), allocatable scalarstructure::scalarstructuresystem::mat
```

Material properties values.

5.2.2.5 rhelem

```
real*8, dimension(:), allocatable scalarstructure::scalarstructuresystem::rhelem
```

Element right-hand system.

5.2.2.6 rhsys

```
real*8, dimension(:), allocatable scalarstructure::scalarstructuresystem::rhsys
```

Global right-hand system.

5.2.2.7 u

```
real*8, dimension(:), allocatable scalarstructure::scalarstructuresystem::u
```

Solution vector.

5.2.2.8 vbc

```
real*8, dimension(:), allocatable scalarstructure::scalarstructuresystem::vbc
```

BC values vector.

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

- src/scalarStructure.F90

Chapter 6

File Documentation

6.1 src/driver.F90 File Reference

Functions/Subroutines

- program finel

  A FINite ELement program for general purpose problems. The present is based in the book "Finite Elements: An Introduction" wrote by Eric Becker, Graham Carey and Tinsley Oden.

6.1.1 Function/Subroutine Documentation

6.1.1.1 finel()

```
program finel ( )
```

A FINite ELement program for general purpose problems. The present is based in the book "Finite Elements: An Introduction" wrote by Eric Becker, Graham Carey and Tinsley Oden.

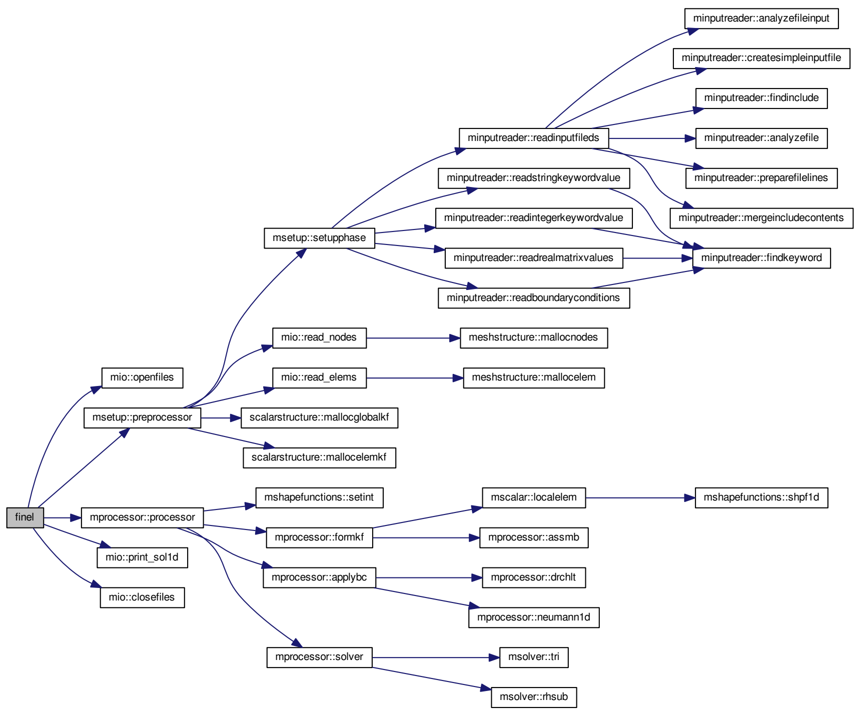
Due to the evolution of Fortran programming language, the code developed here incorporate several changes comparing to the original given in the book cited before. Modular paradigm was employed, as well a little of derived data structure.

Implementations by Diego T. Volpatto. email: `volpatto@lncc.br` or `dtvolpatto@gmail.com`

Author

Diego Tavares Volpatto

Here is the call graph for this function:


minputreader::analyzefileinput
minputreader::createsimpleinputfile
minputreader::findinclude
minputreader::readinputfileds
minputreader::analyzefile
minputreader::readstringkeywordvalue
minputreader::preparefilelines
minputreader::readintegerkeywordvalue
minputreader::mergeincludecontents
msetup::setupphase
minputreader::readrealmatrixvalues
minputreader::findkeyword
minputreader::readboundaryconditions
mio::read_nodes
meshstructure::mallocnodes
mio::openfiles
mio::read_elems
meshstructure::mallocelem
msetup::preprocessor
scalarstructure::mallocglobalkf
scalarstructure::mallocelemkf
mshapefunctions::setint
mscalar::localelem
mshapefunctions::shpf1d
finel
mprocessor::processor
mprocessor::formkf
mprocessor::assmb
mio::print_sol1d
mprocessor::applybc
mprocessor::drchlt
mio::closefiles
mprocessor::neumann1d
mprocessor::solver
msolver::tri
msolver::rhsub

6.2 src/io.F90 File Reference

Modules

- module mio

Functions/Subroutines

- subroutine mio::openfiles ()

    Open IO files.
- subroutine mio::closefiles ()

    Close IO files.
- subroutine mio::read_nodes (mesh_)

    Subroutine to read node data file generated by EasyMesh.
- subroutine mio::read_elems (mesh_)

    Subroutine to read element data file generated by EasyMesh.
- subroutine mio::print_sol1d (mesh_, scalar_)

Variables

- integer, parameter mio::iin = 111

  Input file id.
- integer, parameter mio::iout = 112

  Output file id.
- integer, parameter mio::isol = 113

  Solution file id.
- character(len=20), parameter mio::infile ='input.dat'

  Input file name.
- character(len=20), parameter mio::outfile ='output.dat'

  Output file name.
- character(len=20), parameter mio::solfile ='solution.dat'

  Solution file name.
- character(len=50) mio::title

6.3 src/meshStructure.F90 File Reference

Data Types

- type meshstructure::mesh

  Data type for a mesh.

Modules

- module meshstructure

  Module that contains the data structure of a mesh associate to a problem.

Functions/Subroutines

- subroutine meshstructure::mallocnodes (meshStrct, n)

  Routine that allocate memory to node data.
- subroutine meshstructure::mallocelem (meshStrct, n)

  Routine that allocate memory to element data.

6.4 src/mInputReader.F90 File Reference

Modules

- module minputreader

  Modulo responsavel por reunir subrotinas para leitura do arquivo de entrada.

Functions/Subroutines

- subroutine minputreader::readinputfileds ()

  Le arquivo de input e armazena seu conteudo em um array.
- subroutine minputreader::createsimpleinputfile ()

  Cria a estrutura de input usando um arquivo de entrada sem includes.
- subroutine minputreader::mergeincludecontents (include_file, include_line)

  Le o conteudo do arquivo de include e armazena no array principal.
- subroutine minputreader::preparefilelines (include_indexes, include_number_of_lines, number_of_includes, original_file_lines)

  Efetua a alocacao da estrutura definitiva, preparando a linha dos arquivos originais para receber os includes.
- subroutine minputreader::analyzefileinput (number_of_lines, number_of_includes)

  Efetua algumas analises no arquivo recebido.
- subroutine minputreader::analyzefile (file_name, number_of_lines, number_of_includes)

  Efetua algumas analises no arquivo recebido.
- integer ∗4 function minputreader::findinclude (position, file_lines, number_of_lines)

  Procura a n-esima palavra-chave include.
- integer ∗4 function minputreader::findkeyword (keyword)

  Procura uma palavra-chave.
- subroutine minputreader::readintegerkeywordvalue (keyword, target, default_value)

  Efetua a leitura de uma palavra-chave to tipo inteiro. Se nao encontrado, associa o valor default fornecido.
- subroutine minputreader::readintarraykeywordvalue (keyword, target, default_value)

  Efetua a leitura de uma palavra-chave do tipo array de inteiro. Se nao encontrado, associa o valor default fornecido. Obs.: Atentar para o fato dessa sub-rotina ter um do "infinito".
- subroutine minputreader::readstringkeywordvalue (keyword, target, default_value)

  Efetua a leitura de uma palavra-chave to tipo string. Se nao encontrado, associa o valor default fornecido.
- subroutine minputreader::readrealkeywordvalue (keyword, target, default_value)

  Efetua a leitura de uma palavra-chave to tipo real. Se nao encontrado, associa o valor default fornecido.
- subroutine minputreader::readrealmatrixvalues (keyword, target, default_value)

  Efetua a leitura de uma palavra-chave do tipo de um array bidimensional real. A leitura eh realizada linha por linha. Se nao encontrado, associa o valor default fornecido.
- subroutine minputreader::readboundaryconditions (keyword, kbc, vbc, default_value)

  Efetua a leitura de uma palavra-chave do tipo de um array bidimensional real. A leitura eh realizada linha por linha. Se nao encontrado, associa o valor default fornecido.

Variables

- character(len=200), dimension(:), allocatable minputreader::file_lines

  Armazena as linhas do arquivo de input.
- integer ∗4 minputreader::number_of_lines

  Armazena o numero de linhas no arquivo.

6.5 src/processor.F90 File Reference

Modules

- module mprocessor

  Processor module to compute, assemble and solve the system.

Functions/Subroutines

- subroutine mprocessor::formkf (mesh_, scalar_)

  Form and assemble Ku = F system.
- subroutine mprocessor::assmb (mesh_, scalar_, nel)

  Assemble element stiffness matrix and load vector to global stiffness matrix and load vector, respectively.
- subroutine mprocessor::drchlt (mesh_, scalar_, n)

  Apply Dirichlet Boundary Condition.
- subroutine mprocessor::neumann1d (mesh_, scalar_, n)

  Apply Neumann Boundary Condition – 1D. Prescribe -k(x)u = vbc.
- subroutine mprocessor::applybc (mesh_, scalar_)

  Modify Ku=F system to incorporate BC data.
- subroutine mprocessor::solver (mesh_, scalar_)
- subroutine mprocessor::processor (mesh_, scalar_)

  Processor routine phase.

6.6 src/scalar.F90 File Reference

Modules

- module mscalar

  Contains variables and subroutine related to a general scalar problem.

Functions/Subroutines

- subroutine mscalar::localelem (mesh_, scalar_, nel)

  Computes a master element contribution – 1D.

6.7 src/scalarStructure.F90 File Reference

Data Types

- type scalarstructure::scalarstructuresystem

  Variables and characteristic data for a scalar problem.

Modules

- module scalarstructure

  Module that contains the data structure of a general scalar problem.

Functions/Subroutines

- subroutine scalarstructure::mallocglobalkf (scalar_, n)

  Routine to allocate and clear the Ku = F system.
- subroutine scalarstructure::mallocelemkf (scalar_, n)

  Routine to allocate and clear the element KF.

6.8 src/setup.F90 File Reference

Modules

- module msetup

  Module for setup phase by IO procedures.

Functions/Subroutines

- subroutine msetup::setupphase (mesh_, scalar_)
- subroutine msetup::preprocessor (mesh_, scalar_)

  Realizes preprocessor routines.

6.9 src/shapeFunctions.F90 File Reference

Modules

- module mshapefunctions

  Module for shape functions computations and relate operations.

Functions/Subroutines

- subroutine mshapefunctions::setint

  Gauss quadrature data set routine.
- subroutine mshapefunctions::shpf1d (xl, n, psi, dpsi)

  Calculates the values of the shape functions and their derivatives.

Variables

- real ∗8, dimension(4, 4) mshapefunctions::xi

  Gauss point integration.
- real ∗8, dimension(4, 4) mshapefunctions::w

  Gauss weights.

6.10 src/solver.F90 File Reference

Modules

- module msolver

  Contains subroutine to compute numerical solution of linear systems Ax=b.

Functions/Subroutines

- subroutine msolver::tri (A, n)

  Applies Gauss reduction in A(n,n) to obtain a superior triangular equivalent form.
- subroutine msolver::rhsub (A, x, b, n)

  Does the forward substitution on the right-side-hand.

6.11 src/utilities.F90 File Reference

Modules

- module mutilities

  Module for auxiliar routines.

Functions/Subroutines

- subroutine mutilities::linspace (x1, x2, nintv, x)

  Generate points between x1 and x2 equally spaced in x(i). Same idea of numpy subroutine.
- real ∗8 function mutilities::f1 (x)

  A function to test purpose.
- subroutine mutilities::quad1 (n, x1, x2)

  Subroutine that computes gaussian quadrature of f1.
- subroutine mutilities::test_shpf1d (n, nelem, x)

  Check if shpf1d works properly.
- subroutine mutilities::print_matrix (A, n, m)

  Prints in the screen a matrix A(n,m)

Index