AMICI

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1 AMICI 0.1 General Documentation

1.1 Introduction

AMICI is a MATLAB interface for the SUNDIALS solvers CVODES (for ordinary differential equations) and IDAS (for algebraic differential equations). AMICI allows the user to specify differential equation models in terms of symbolic variables in MATLAB and automatically compiles such models as .mex simulation files. In contrast to the SUNDIALSTB interface, all necessary functions are transformed into native C code, which allows for a significantly faster numerical integration. Beyond forward integration, the compiled simulation file also allows for first and second order forward sensitivity analysis, steady state sensitivity analysis and adjoint sensitivity analysis for likelihood based output functions.

The interface was designed to provide routines for efficient gradient computation in parameter estimation of biochemical reaction models but is also applicable to a wider range of differential equation constrained optimization problems.

1.2 Availability

The sources for AMICI are accessible as

- Source tarball
- Source zipball
- GIT repository on github

Once you've obtained your copy check out the Installation

1.2.1 Obtaining AMICI via the GIT versioning system

In order to always stay up-to-date with the latest AMICI versions, simply pull it from our GIT repository and recompile it when a new release is available. For more information about GIT checkout their website

The GIT repository can currently be found at https://github.com/FFroehlich/AMICI and a direct clone is possible via

```
git clone https://github.com/FFroehlich/AMICI.git AMICI
```

1.2.2 License Conditions

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1.3 Installation

If AMICI was downloaded as a zip, it needs to be unpacked in a convenient directory. If AMICI was obtained via cloning of the git repository, no further unpacking is necessary.

To use AMICI, start MATLAB and add the AMICI direcory to the MATLAB path. To add all toolbox directories to the MATLAB path, execute the matlab script

```
installToolbox.m
```

To store the installation for further MATLAB session, the path can be saved via

```
savepath
```

For the compilation of .mex files, MATLAB needs to be configured with a working C compiler. The C compiler needs to be installed and configured via:

```
mex -setup c
```

For a list of supported compilers we refer to the mathworks documentation: mathworks.de

The tools SUNDIALS and SuiteSparse shipped with AMICI do **not** require further installation.

AMICI uses the following packages from SUNDIALS:

CVODES: the sensitivity-enabled ODE solver in SUNDIALS. Radu Serban and Alan C. Hindmarsh. *ASME 2005 International Design Engineering Technical Conferences and Computers and Information in Engineering Conference.* American Society of Mechanical Engineers, 2005. PDF

IDAS

AMICI uses the following packages from SuiteSparse:

Algorithm 907: KLU, A Direct Sparse Solver for Circuit Simulation Problems. Timothy A. Davis, Ekanathan Palamadai Natarajan, *ACM Transactions on Mathematical Software*, Vol 37, Issue 6, 2010, pp 36:1 - 36:17. PDF

Algorithm 837: AMD, an approximate minimum degree ordering algorithm, Patrick R. Amestoy, Timothy A. Davis, Iain S. Duff, *ACM Transactions on Mathematical Software*, Vol 30, Issue 3, 2004, pp 381 - 388. PDF

Algorithm 836: COLAMD, a column approximate minimum degree ordering algorithm, Timothy A. Davis, John R. Gilbert, Stefan I. Larimore, Esmond G. Ng *ACM Transactions on Mathematical Software*, Vol 30, Issue 3, 2004, pp 377 - 380. PDF

2 How to contribute

We are happy about contributions to AMICI in any form (new functionality, documentation, bug reports, ...).

Making code changes

When making code changes:

- Check if you agree to release your contribution under the conditions provided in `LICENSE`
- Start a new branch from `master`
- Implement your changes
- Submit a pull request
- Make sure your code is documented appropriately
  - Run `mtoc/makeDocumentation.m` to check completeness of your documentation
- Make sure your code is compatible with C++11, `gcc` and `clang`
- when adding new functionality, please also provide test cases (see `tests/cpputest/`)
- Write meaningful commit messages
- Run all tests to ensure nothing got broken
  - Run `tests/cpputest/wrapTestModels.m` followed by CI tests `scripts/buildAll.sh && scripts/run-cpputest.sh`
  - Run `tests/testModels.m`
- When all tests are passing and you think your code is ready to merge, request a code review

Adding/Updating tests

To add new tests add a new corresponding python script (see, e.g., `tests/example_dirac.py`) and add it to and run `tests/generateTestConfigurationForExamples.sh` To update test results replace `tests/cpputest/expectedResults.h5` by `tests/cpputest/writeResults.h5.bak` [ONLY DO THIS AFTER TRIPLE CHECKING CORRECTNESS OF RESULTS]

3 SBMLimporter

MATLAB toolbox to generate ODE models from SBML files

4 Model Definition & Simulation

In the following we will give a detailed overview how to specify models in AMIWRAP and how to call the generated simulation files.

4.1 Model Definition

This guide will guide the user on how to specify models in MATLAB. For example implementations see the examples in the example directory.

4.1.1 Header

The model definition needs to be defined as a function which returns a struct with all symbolic definitions and options.

```
function [model] = example_model_syms()
```

4.1.2 Options

Set the options by specifying the respective field of the modelstruct

```
model.(fieldname) = (value)
```

The options specify default options for simulation, parametrisation and compilation. All of these options are optional.

field	description	default
.param	parametrisation 'log'/'log10'/'lin'	'lin'
.debug	flag to compile with debug symbols	false
.forward	flag to activate forward sensitivities	true
.adjoint	flag to activate adjoint sensitivities	true

When set to true, the fields 'noforward' and 'noadjoint' will speed up the time required to compile the model but also disable the respective sensitivity computation.

4.1.3 States

Create the respective symbolic variables. The name of the symbolic variable can be chosen arbitrarily.

```
syms state1 state2 state3
```

Create the state vector containing all states:

```
x = [ state1 state2 state3 ];
```

4.1.4 Parameters

Create the respective symbolic variables. The name of the symbolic variable can be chosen arbitrarily. Sensitivities **will be derived** for all paramaters.

```
syms param1 param2 param3 param4 param5 param6
```

Create the parameters vector

```
p = [ param1 param2 param3 param4 param5 param6 ];
```

4.1.5 Constants

Create the respective symbolic variables. The name of the symbolic variable can be chosen arbitrarily. Sensitivities with respect to constants **will not be derived**.

```
syms const1 const2
```

Create the parameters vector

```
k = [ const1 const2 ];
```

4.1.6 Differential Equation

For time-dependent differential equations you can specify a symbolic variable for time. This **needs** to be denoted by t.

```
syms t
```

Specify the right hand side of the differential equation f or xdot

```
xdot(1) = [ const1 - param1*state1 ];
xdot(2) = [ +param2*state1 + dirac(t-param3) - const2*state2 ];
xdot(3) = [ param4*state2 ];
```

or

```
f(1) = [ const1 - param1*state1 ];
f(2) = [ +param2*state1 + dirac(t-param3) - const2*state2 ];
f(3) = [ param4*state2 ];
```

The specification of f or xdot may depend on States, Parameters and Constants.

For DAEs also specify the mass matrix.

```
M = [1, 0, 0;...
0, 1, 0;...
0, 0, 0];
```

The specification of M may depend on parameters and constants.

For ODEs the integrator will solve the equation $\dot{x} = f$ and for DAEs the equations $M \cdot \dot{x} = f$. AMICI will decide whether to use CVODES (for ODEs) or IDAS (for DAEs) based on whether the mass matrix is defined or not.

In the definition of the differential equation you can use certain symbolic functions. For a full list of available functions see symbolic_functions.c.

Dirac functions can be used to cause a jump in the respective states at the specified time-point. This is typically used to model injections, or other external stimuli. Spline functions can be used to model time/state dependent response with unkown time/state dependence.

4.1.7 Initial Conditions

Specify the initial conditions. These may depend on Parameters on Constants and must have the same size as x.

```
x0 = [ param4, 0, 0 ];
```

4.1.8 Observables

Specify the observables. These may depend on Parameters and Constants.

```
y(1) = state1 + state2;
y(2) = state3 - state2;
```

In the definition of the observable you can use certain symbolic functions. For a full list of available functions see symbolic_functions.c. Dirac functions in observables will have no effect.

4.1.9 Events

Specifying events is optional. Events are specified in terms of a trigger function, a bolus fuction and an output function. The roots of the trigger function defines the occurences of the event. The bolus function defines the change in the state on event occurences. The output function defines the expression which is evaluated and reported by the simulation routine on every event occurence. The user can create events by constructing a vector of objects of the class amievent.

```
event(1) = amievent(state1 - state2,0,[]);
```

Events may depend on States, Parameters and Constants but **not** on Observables

4.1.10 Standard Deviation

Specifying of standard deviations is optional. It only has an effect when computing adjoint sensitivities. It allows the user to specify standard deviations of experimental data for Observables and Events.

Standard deviaton for observable data is denoted by sigma_y

```
sigma_y(1) = param5;
```

Standard deviaton for event data is denoted by sigma_y

```
sigma_t(1) = param6;
```

Both sigma_y and sigma_t can either be a scalar or of the same dimension as the Observables / Events function. They can depend on time and Parameters but must not depend on the States or Observables. The values provided in sigma_y and sigma_t will only be used if the value in Sigma_Y or Sigma_T in the user-provided data struct is NaN. See Model Simulation for details.

4.1.11 Attach to Model Struct

Eventually all symbolic expressions need to be attached to the model struct.

```
model.sym.x = x;
model.sym.k = k;
model.sym.event = event;
model.sym.xdot = xdot;
% or
model.sym.f = f;
model.sym.M = M; %only for DAEs
model.sym.p = p;
model.sym.x0 = x0;
model.sym.y = y;
model.sym.sigma_y = sigma_y;
model.sym.sigma_t = sigma_t;
```

4.2 Model Compilation

The model can then be compiled by calling amiwrap:

```
amiwrap(modelname,'example_model_syms',dir,o2flag)
```

Here modelname should be a string defining the modelname, dir should be a string containing the path to the directory in which simulation files should be placed and o2flag is a flag indicating whether second order sensitivities should also be compiled. The user should make sure that the previously defined function 'example_model_syms' is in the user path. Alternatively, the user can also call the function 'example_model_syms'

```
[model] = example_model_syms()
```

and subsequently provide the generated struct to amiwrap(), instead of providing the symbolic function:

```
amiwrap(modelname,model,dir,o2flag)
```

In a similar fashion, the user could also generate multiple model and pass them directly to amiwrap() without generating respective model definition scripts.

See also

amiwrap()

4.3 Model Simulation

After the call to amiwrap() two files will be placed in the specified directory. One is a am_*modelname*.mex and the other is simulate_*modelname*.m. The mex file should never be called directly. Instead the MATLAB script, which acts as a wrapper around the .mex simulation file should be used.

The simulate_*modelname*.m itself carries extensive documentation on how to call the function, what it returns and what additional options can be specified. In the following we will give a short overview of possible function calls.

4.3.1 Integration

Define a time vector:

```
t = linspace(0,10,100)
```

Generate a parameter vector:

```
theta = ones(6,1);
```

Generate a constants vector:

```
kappa = ones(2,1);
```

Integrate:

```
sol = simulate_modelname(t,theta,kappa,[],options)
```

The integration status will be indicated by the sol.status flag. Negative values indicated failed integration. The states will then be available as sol.x. The observables will then be available as sol.y. The events will then be available as sol.root. If no event occured there will be an event at the end of the considered interval with the final value of the root function stored in sol.rval.

Alternatively the integration call also be called via

```
[status,t,x,y] = simulate_modelname(t,theta,kappa,[],options)
```

The integration status will be indicated by the status flag. Negative values indicated failed integration. The states will then be available as x. The observables will then be available as y. No event output will be given.

4.3.2 Forward Sensitivities

Define a time vector:

```
t = linspace(0,10,100)
```

Generate a parameter vector:

```
theta = ones(6,1);
```

Generate a constants vector:

```
kappa = ones(2,1);
```

Set the sensitivity computation to forward sensitivities and Integrate:

```
options.sensi = 1;
options.forward = true;
sol = simulate_modelname(t,theta,kappa,[],options)
```

The integration status will be indicated by the sol.status flag. Negative values indicated failed integration. The states will then be available as sol.x, with the derivative with respect to the parameters in sol.sx. The observables will then be available as sol.y, with the derivative with respect to the parameters in sol.sy. The events will then be available as sol.root, with the derivative with respect to the parameters in sol.sroot. If no event occured there will be an event at the end of the considered interval with the final value of the root function stored in sol.rootval, with the derivative with respect to the parameters in sol.srootval

Alternatively the integration call also be called via

```
[status,t,x,y,sx,sy] = simulate_modelname(t,theta,kappa,[],options)
```

The integration status will be indicated by the status flag. Negative values indicated failed integration. The states will then be available as x, with derivative with respect to the parameters in sx. The observables will then be available as y, with derivative with respect to the parameters in sy. No event output will be given.

4.3.3 Adjoint Sensitivities

Define a time vector:

```
t = linspace(0,10,100)
```

Generate a parameter vector:

```
theta = ones(6,1);
```

Set the sensitivity computation to adjoint sensitivities:

```
options.sensi = 1;
options.adjoint = true;
```

Define Experimental Data:

```
D.Y = [NaN(1,2)],ones(length(t)-1,2)];
D.Sigma_Y = [0.1*ones(length(t)-1,2),NaN(1,2)];
D.T = ones(1,1);
D.Sigma_T = NaN;
```

The NaN values in Sigma_Y and Sigma_T will be replaced by the specification in Standard Deviation. Data points with NaN value will be completely ignored.

Generate a constants vector:

```
kappa = ones(2,1);
```

Integrate:

```
sol = simulate_modelname(t,theta,kappa,D,options)
```

The integration status will be indicated by the sol.status flag. Negative values indicated failed integration. The log-likelihood will then be available as sol.llh and the derivative with respect to the parameters in sol.sllh. Notice that for adjoint sensitivities no state, observable and event sensitivities will be available. Yet this approach can be expected to be significantly faster for systems with a large number of parameters.

4.3.4 Steady State Sensitivities

This will compute state sensitivities according to the formula $s_k^x = -\left(\frac{\partial f}{\partial x}\right)^{-1} \frac{\partial f}{\partial \theta_k}$

In the current implementation this formulation does not allow for conservation laws as this would result in a singular Jacobian.

Define a final timepoint t:

```
t = 100
```

Generate a parameter vector:

```
theta = ones(6,1);
```

Generate a constants vector:

```
kappa = ones(2,1);
```

Set the sensitivity computation to steady state sensitivities:

```
options.sensi = 1;
options.ss = 1;
```

Integrate:

```
sol = simulate_modelname(t,theta,kappa,D,options)
```

The states will then be available as sol.x, with the derivative with respect to the parameters in sol.sx. The observables will then be available as sol.y, with the derivative with respect to the parameters in sol.sy. Notice that for steady state sensitivities no event sensitivities will be available. For the accuracy of the computed derivatives it is essential that the system is sufficiently close to a steady state. This can be checked by examining the right hand side of the system at the final time-point via sol.xdot.

5 Code Organization

In the following we will briefly outline what happens when a model is compiled. For a more detailed description we refer the reader to the documentation of the individual functions.

After specifying a model (see Model Definition) the user will typically compile the model by invoking amiwrap(). amiwrap() first instantiates an object of the class amimodel. The properties of this object are initialised based on the user-defined model. If the o2flag is active, all subsequent computations will also be carried out on the augmented system, which also includes the equations for forward sensitivities. This allows the computation of second order sensitivities in a forward-forward approach. A forward-adjoint approach will be implemented in the future.

The fun fields of this object will then be populated by amimodel::parseModel(). The amimodel::fun field contains all function definitions of type amifun which are required for model compilation. The set of functions to be considered will depend on the user specification of the model fields amimodel::adjoint and amimodel::forward (see Options) as well as the employed solver (CVODES or IDAS, see Differential Equation). For all considered functions amimodel::parseModel() will check their dependencies via amimodel::checkDeps(). These dependencies are

a subset of the user-specified fields of amimodel::fun (see Attach to Model Struct). amimodel::parseModel() compares the hashes of all dependencies against the amimodel::HTable of possible previous compilations and will only compute necessary symbolic expressions if changes in these fields occured.

For all functions for which amimodel::fun exists, amimodel::generateC() will generate C files. These files together with their respective header files will be placed in $AMICIDIR/models/*modelname*. amimodel::generateC() will also generate wrapfunctions.h and wrapfunctions.c. These files define and declare model unspecific wrapper functions around model specific functions. This construction allows us to use to build multiple different models against the same simulation routines by linking different realisations of these wrapper functions.

All the generated C functions are subsequently compiled by amimodel::compileC(). For all functions individual object files are created to reduce the computation cost of code optimization. Moreover necessary code from sundials and SuiteSparse is compiled as object files and placed in /models/*mexext*, where mexext stands for the string returned by matlab to the command mexext. The mex simulation file is compiled from amiwrap.c, linked against all object necessary of sundials, SuiteSparse and model specific functions. Depending on the required solver, the compilation will either include cvodewrap.h or idawrap.h. These files implement solver specific realisations of the AMI... functions used in amiwrap.c and amici.c. This allows the use of the same simulation routines for both CVODES and IDAS.

6 Using AMICI-generated code outside Matlab

AMICI (amiwrap.m) translates the model definition into C++ code which is then compiled into a mex file for MATLAB. Advanced users can use this code within stand-online C/C++ applications for use in non-MATLAB environments (e.g. on high performance computing systems). This section will give a short overview over the generated files and provide a brief introduction of how this code can be included in other applications.

Generated model files

amiwrap.m usually write the model source files to ${AMICI_ROOT_DIR}/models/${MODEL_NAME} by default. The content of a model source directory might look something like this (given `MODEL_NAME=model_steadystate`):

```
CMakeLists.txt
hashes.mat
main.cpp
model_steadystate_deltaqB.cpp
model_steadystate_deltaqB.h
model_steadystate_deltaqB_mexa64.md5
model_steadystate_deltaqB.o
[... many more files model_steadystate_*.(cpp|h|md5|o) ]
wrapfunctions.cpp
wrapfunctions.h
wrapfunctions.o
```

Only `*.cpp` and `*.h` files will be needed for the model; `*.o` and `*.md5` are not required.

Running a simulation

The entry function for running an AMICI simulation is getSimulationResults(), declared in amici.h. This function requires all AMICI options and any experimental data. All options that would normally be passed to `simulate_${MODEL_NAME}()` in MATLAB are passed in a UserData struct (see `udata.h` for info). Any experimental data will be passed as ExpData struct (`edata.h`). The simulation results will be returned in a ReturnData struct (see `rdata.h`).

A scaffold for a standalone simulation program is generated in `main.cpp` in the model source directory. This programm shows how to initialize the above-mentioned structs and how to obtain the simulation results.

Compiling and linking

The complete AMICI API is available through amici.h; this is the only header file that needs to be included. (There are some accessor macro definitions available in udata_accessors.h, rdata_accessors.h and edata_accessors.h which provide shortcuts for accessing struct members of UserData, ReturnData, ExpData, respectively. `amici_hdf5.h` provides some functions for reading and writing HDF5 files).

You need to compile and link `${AMICI_ROOT_DIR}/models/${MODEL_NAME}/*.cpp`, `${AMICI_ROOT_DIR}/src/*.c` the SUNDIALS and the SUITESPARSE library.

Along with `main.cpp`, a CMake file (`CMakeLists.txt`) will be generated automatically. The CMake file shows the abovementioned library dependencies. These files provide a scaffold for a standalone simulation program. The required numerical libraries are shipped with AMICI. To compile them, run `${AMICI_ROOT_DIR}/scripts/run-tests.sh` once. HDF5 libraries and header files need to be installed separately. More information on how to run the compiled program is provided in `main.cpp`. (NOTE: This sample program should compile and link, but will crash most certainly without further problem-specific adaptations.)

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7.1 Class Hierarchy

This inheritance list is sorted roughly, but not completely, alphabetically:

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8.1 Class List

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9 Class Documentation

9.1 AmiException Class Reference

amici exception handler class

```
#include <exception.h>
```

Inheritance diagram for AmiException:

Collaboration diagram for AmiException:

Public Member Functions

- AmiException (char const ∗fmt,...)
- AmiException (const AmiException &old)
- const char ∗ what () const throw ()
- const char ∗ getBacktrace () const
- void storeBacktrace (const int nMaxFrames)

9.1.1 Detailed Description

has a printf style interface to allow easy generation of error messages

Definition at line 29 of file exception.h.

9.1.2 Constructor & Destructor Documentation

9.1.2.1 AmiException() [1/2]

```
AmiException (
            char const * fmt,
             ...  )
```

constructor with printf style interface

Parameters

in	*fmt*	error message with printf format
in	...	printf formating variables

Definition at line 31 of file exception.h.

Here is the call graph for this function:

9.1.2.2 AmiException() [2/2]

```
AmiException (
            const AmiException & old )
```

copy constructor

Parameters

old	object to copy from

Definition at line 43 of file exception.h.

9.1.3 Member Function Documentation

9.1.3.1 what()

```
const char* what ( ) const throw )
```

override of default error message function

Returns

msg error message

Definition at line 54 of file exception.h.

9.1.3.2 getBacktrace()

```
const char* getBacktrace ( ) const
```

returns the stored backtrace

Returns

trace backtrace

Definition at line 61 of file exception.h.

9.1.3.3 storeBacktrace()

```
void storeBacktrace (
            const int nMaxFrames )
```

stores the current backtrace

Parameters

nMaxFrames	number of frams to go back in stacktrace

Definition at line 68 of file exception.h.

Here is the caller graph for this function:

9.2 AmiVector Class Reference

```
#include <vector.h>
```

Public Member Functions

- AmiVector (const long int length)
- AmiVector (std::vector< realtype > rvec)
- AmiVector (const AmiVector &vold)
- AmiVector & operator= (AmiVector &other)
- realtype * data ()
- const realtype * data () const
- N_Vector getNVector () const
- std::vector< realtype > getVector () const
- int getLength () const
- void reset ()
- void minus ()
- void set (realtype val)
- realtype & operator[ ] (int pos)
- realtype & at (int pos)
- ~AmiVector ()

9.2.1 Detailed Description

AmiVector class. provides a generic interface to the NVector_Serial struct

Definition at line 15 of file vector.h.

9.2.2 Constructor & Destructor Documentation

9.2.2.1 AmiVector() [1/3]

```
AmiVector (
            const long int length )
```

default constructor creates an std::vector<realype> and attaches the data pointer to a newly created N_Vector_Serial using N_VMake_Serial ensures that the N_Vector module does not try to deallocate the data vector when calling N_VDestroy_Serial

Parameters

length	number of elements in vector

Returns

new AmiVector instance

Definition at line 26 of file vector.h.

9.2.2.2 AmiVector() [2/3]

```
AmiVector (
            std::vector< realtype > rvec )
```

constructor from vector, copies data from vector and constructs an nvec that points to the data

Parameters

rvec	vector from which the data will be copied

Returns

new AmiVector instance

Definition at line 35 of file vector.h.

9.2.2.3 AmiVector() [3/3]

```
AmiVector (
            const AmiVector & vold )
```

copy constructor

Parameters

vold	vector from which the data will be copied

Definition at line 43 of file vector.h.

9.2.2.4 ~AmiVector()

```
~AmiVector ( )
```

default destructor creates an std::vector<realype> and attaches the data pointer to a newly created N_Vector_Serial

Definition at line 136 of file vector.h.

9.2.3 Member Function Documentation

9.2.3.1 operator=()

```
AmiVector& operator= (
            AmiVector & other )
```

copy-move assignment operator

Parameters

other	right hand side

Returns

left hand side

Definition at line 52 of file vector.h.

9.2.3.2 data() [1/2]

```
realtype* data ( )
```

data accessor

Returns

pointer to data array

Definition at line 63 of file vector.h.

Here is the caller graph for this function:

9.2.3.3 data() [2/2]

```
const realtype* data ( ) const
```

const data accessor

Returns

const pointer to data array

Definition at line 70 of file vector.h.

9.2.3.4 getNVector()

```
N_Vector getNVector ( ) const
```

N_Vector accessor

Returns

N_Vector

Definition at line 77 of file vector.h.

Here is the caller graph for this function:

9.2.3.5 getVector()

```
std::vector<realtype> getVector ( ) const
```

Vector accessor

Returns

Vector

Definition at line 84 of file vector.h.

9.2.3.6 getLength()

```
int getLength ( ) const
```

returns the length of the vector

Returns

length

Definition at line 91 of file vector.h.

9.2.3.7 reset()

```
void reset ( )
```

resets the Vector by filling with zero values

Definition at line 97 of file vector.h.

Here is the caller graph for this function:

9.2.3.8 minus()

```
void minus ( )
```

changes the sign of data elements

Definition at line 103 of file vector.h.

Here is the caller graph for this function:

9.2.3.9 set()

```
void set (
            realtype val )
```

sets all data elements to a specific value

Parameters

val	value for data elements

Definition at line 112 of file vector.h.

Here is the caller graph for this function:

9.2.3.10 operator[]()

```
realtype& operator[] (
            int pos )
```

accessor to data elements of the vector

Parameters

pos	index of element

Returns

element

Definition at line 120 of file vector.h.

9.2.3.11 at()

```
realtype& at (
            int pos )
```

accessor to data elements of the vector

Parameters

pos	index of element

Returns

element

Definition at line 128 of file vector.h.

Here is the caller graph for this function:

9.3 AmiVectorArray Class Reference

```
#include <vector.h>
```

Public Member Functions

- AmiVectorArray (const long int length_inner, const long int length_outer)
- AmiVectorArray (const AmiVectorArray &vaold)
- realtype ∗ data (int pos)

- const realtype ∗ data (int pos) const
- realtype & at (int ipos, int jpos)
- N_Vector ∗ getNVectorArray ()
- N_Vector getNVector (int pos)
- AmiVector & operator[ ] (int pos)
- const AmiVector & operator[ ] (int pos) const
- int getLength () const
- void reset ()
- ∼AmiVectorArray ()

9.3.1 Detailed Description

AmiVectorArray class. provides a generic interface to arrays of NVector_Serial structs

Definition at line 152 of file vector.h.

9.3.2 Constructor & Destructor Documentation

9.3.2.1 AmiVectorArray() [1/2]

```
AmiVectorArray (
            const long int length_inner,
            const long int length_outer )
```

default constructor creates an std::vector<realype> and attaches the data pointer to a newly created N_VectorArray using CloneVectorArrayEmpty ensures that the N_Vector module does not try to deallocate the data vector when calling N_VDestroyVectorArray_Serial

Parameters

length_inner	length of vectors
length_outer	number of vectors

Returns

New AmiVectorArray instance

Definition at line 164 of file vector.h.

9.3.2.2 AmiVectorArray() [2/2]

```
AmiVectorArray (
            const AmiVectorArray & vaold )
```

copy constructor

Parameters

vaold	object to copy from

Returns

new AmiVectorArray instance

Definition at line 177 of file vector.h.

Here is the call graph for this function:

9.3.2.3 ~AmiVectorArray()

```
~AmiVectorArray ( )
```

default destructor

Definition at line 257 of file vector.h.

9.3.3 Member Function Documentation

9.3.3.1 data() [1/2]

```
realtype* data (
            int pos )
```

accessor to data of AmiVector elements

Parameters

pos	index of AmiVector

Returns

pointer to data array

Definition at line 188 of file vector.h.

Here is the caller graph for this function:

9.3.3.2 data() [2/2]

```
const realtype* data (
            int pos ) const
```

const accessor to data of AmiVector elements

Parameters

pos	index of AmiVector

Returns

const pointer to data array

Definition at line 196 of file vector.h.

9.3.3.3 at()

```
realtype& at (
            int ipos,
            int jpos )
```

accessor to elements of AmiVector elements

Parameters

ipos	inner index in AmiVector
jpos	outer index in AmiVectorArray

Returns

element

Definition at line 205 of file vector.h.

Here is the caller graph for this function:

9.3.3.4 getNVectorArray()

```
N_Vector* getNVectorArray ( )
```

accessor to NVectorArray

Returns

N_VectorArray

Definition at line 212 of file vector.h.

9.3.3.5 getNVector()

```
N_Vector getNVector (
            int pos )
```

accessor to NVector element

Parameters

pos	index of corresponding AmiVector

Returns

N_Vector

Definition at line 220 of file vector.h.

9.3.3.6 operator[]() [1/2]

```
AmiVector& operator[] (
            int pos )
```

accessor to AmiVector elements

Parameters

pos	index of AmiVector

Returns

AmiVector

Definition at line 228 of file vector.h.

9.3.3.7 operator[]() [2/2]

```
const AmiVector& operator[] (
            int pos ) const
```

const accessor to AmiVector elements

Parameters

pos	index of AmiVector

Returns

const AmiVector

Definition at line 236 of file vector.h.

9.3.3.8 getLength()

```
int getLength ( ) const
```

length of AmiVectorArray

Returns

length

Definition at line 243 of file vector.h.

Here is the caller graph for this function:

9.3.3.9 reset()

```
void reset ( )
```

resets every AmiVector in AmiVectorArray

Definition at line 249 of file vector.h.

Here is the caller graph for this function:

9.4 BackwardProblem Class Reference

class to solve backwards problems.

```
#include <backwardproblem.h>
```

Public Member Functions

- void workBackwardProblem ()
- BackwardProblem (ForwardProblem *fwd)
- realtype gett () const
- int getwhich () const
- int * getwhichptr ()
- AmiVector * getxBptr ()
- AmiVector * getxQBptr ()
- AmiVector * getdxBptr ()
- std::vector< realtype > getdJydx () const

9.4.1 Detailed Description

solves the backwards problem for adjoint sensitivity analysis and handles events and data-points

Definition at line 23 of file backwardproblem.h.

9.4.2 Constructor & Destructor Documentation

9.4.2.1 BackwardProblem()

```
BackwardProblem (
            ForwardProblem * fwd )
```

default constructor

Parameters

fwd	pointer to corresponding forward problem

Returns

new BackwardProblem instance

Definition at line 18 of file backwardproblem.cpp.

Here is the call graph for this function:

9.4.3 Member Function Documentation

9.4.3.1 workBackwardProblem()

```
void workBackwardProblem ( )
```

workBackwardProblem solves the backward problem. if adjoint sensitivities are enabled this will also compute sensitivies workForwardProblem should be called before this is function is called

Definition at line 44 of file backwardproblem.cpp.

Here is the call graph for this function:

9.4.3.2 gett()

```
realtype gett ( ) const
```

accessor for t

Returns

t

Definition at line 32 of file backwardproblem.h.

Here is the caller graph for this function:

9.4.3.3 getwhich()

```
int getwhich ( ) const
```

accessor for which

Returns

which

Definition at line 39 of file backwardproblem.h.

Here is the caller graph for this function:

9.4.3.4 getwhichptr()

```
int* getwhichptr ( )
```

accessor for pointer to which

Returns

which

Definition at line 46 of file backwardproblem.h.

Here is the caller graph for this function:

9.4.3.5 getxBptr()

```
AmiVector* getxBptr ( )
```

accessor for pointer to xB

Returns

&xB

Definition at line 53 of file backwardproblem.h.

Here is the caller graph for this function:

9.4.3.6 getxQBptr()

```
AmiVector* getxQBptr ( )
```

accessor for pointer to xQB

Returns

&xQB

Definition at line 60 of file backwardproblem.h.

Here is the caller graph for this function:

9.4.3.7 getdxBptr()

```
AmiVector* getdxBptr ( )
```

accessor for pointer to dxB

Returns

&dxB

Definition at line 67 of file backwardproblem.h.

Here is the caller graph for this function:

9.4.3.8 getdJydx()

```
std::vector<realtype> getdJydx ( ) const
```

accessor for dJydx

Returns

dJydx

Definition at line 74 of file backwardproblem.h.

Here is the caller graph for this function:

9.5 CvodeException Class Reference

cvode exception handler class

```
#include <exception.h>
```

Inheritance diagram for CvodeException:

Collaboration diagram for CvodeException:

Public Member Functions

- CvodeException (const int error_code, const char *function)

9.5.1 Detailed Description

Definition at line 117 of file exception.h.

9.5.2 Constructor & Destructor Documentation

9.5.2.1 CvodeException()

```
CvodeException (
            const int error_code,
            const char * function )
```

constructor

Parameters

in	*error_code*	error code returned by cvode function
in	*function*	cvode function name

Definition at line 123 of file exception.h.

9.6 ExpData Class Reference

ExpData carries all information about experimental or condition-specific data.

```
#include <edata.h>
```

Public Member Functions

- ExpData ()
- ExpData (int nytrue, int nztrue, int nt, int nmaxevent)

  ExpData.
- ExpData (int nytrue, int nztrue, int nt, int nmaxevent, std::vector< realtype > const &my, std::vector< realtype > const &sigmay, std::vector< realtype > const &mz, std::vector< realtype > const &sigmaz)

  ExpData.
- ExpData (const Model &model)
- ExpData (const ExpData &other)

  Copy constructor.
- void setObservedData (const double *observedData)
- void setObservedDataStdDev (const double *observedDataStdDev)
- void setObservedEvents (const double *observedEvents)
- void setObservedEventsStdDev (const double *observedEventsStdDev)

Public Attributes

- std::vector< realtype > my
- std::vector< realtype > sigmay
- std::vector< realtype > mz
- std::vector< realtype > sigmaz
- const int nytrue
- const int nztrue
- const int nt
- const int nmaxevent
- std::vector< realtype > fixedParameters
- std::vector< realtype > fixedParametersPreequilibration

9.6.1 Detailed Description

Definition at line 13 of file edata.h.

9.6.2 Constructor & Destructor Documentation

9.6.2.1 ExpData() [1/5]

```
ExpData ( )
```

default constructor

Definition at line 10 of file edata.cpp.

9.6.2.2 ExpData() [2/5]

```
ExpData (
            int nytrue,
            int nztrue,
            int nt,
            int nmaxevent )
```

Parameters

nytrue	
nztrue	
nt	
nmaxevent	

Definition at line 12 of file edata.cpp.

9.6.2.3 ExpData() [3/5]

```
ExpData (
            int nytrue,
            int nztrue,
            int nt,
            int nmaxevent,
            std::vector< realtype > const & my,
            std::vector< realtype > const & sigmay,
            std::vector< realtype > const & mz,
            std::vector< realtype > const & sigmaz )
```

Parameters

nytrue	

Parameters

nztrue	
nt	
nmaxevent	
my	
sigmay	
mz	
sigmaz	

Definition at line 22 of file edata.cpp.

9.6.2.4 ExpData() [4/5]

```
ExpData (
            const Model & model )
```

constructor that initializes with Model

Parameters

model	pointer to model specification object **Type**: Model

Definition at line 33 of file edata.cpp.

9.6.2.5 ExpData() [5/5]

```
ExpData (
            const ExpData & other )
```

Parameters

other	object to copy from

Definition at line 38 of file edata.cpp.

9.6.3 Member Function Documentation

9.6.3.1 setObservedData()

```
void setObservedData (
            const double * observedData )
```

set function that copies data from input to ExpData::my

Parameters

observedData	observed data

Definition at line 44 of file edata.cpp.

9.6.3.2 setObservedDataStdDev()

```
void setObservedDataStdDev (
            const double * observedDataStdDev )
```

set function that copies data from input to ExpData::sigmay

Parameters

observedDataStdDev	standard deviation of observed data

Definition at line 55 of file edata.cpp.

9.6.3.3 setObservedEvents()

```
void setObservedEvents (
            const double * observedEvents )
```

set function that copies data from input to ExpData::mz

Parameters

observedEvents	observed event data

Definition at line 66 of file edata.cpp.

9.6.3.4 setObservedEventsStdDev()

```
void setObservedEventsStdDev (
            const double * observedEventsStdDev )
```

set function that copies data from input to ExpData::sigmaz

Parameters

observedEventsStdDev	standard deviation of observed event data

Definition at line 77 of file edata.cpp.

9.6.4 Member Data Documentation

9.6.4.1 my

```
std::vector<realtype> my
```

observed data (dimension: nt x nytrue, row-major)

Definition at line 66 of file edata.h.

9.6.4.2 sigmay

```
std::vector<realtype> sigmay
```

standard deviation of observed data (dimension: nt x nytrue, row-major)

Definition at line 68 of file edata.h.

9.6.4.3 mz

```
std::vector<realtype> mz
```

observed events (dimension: nmaxevents x nztrue, row-major)

Definition at line 71 of file edata.h.

9.6.4.4 sigmaz

```
std::vector<realtype> sigmaz
```

standard deviation of observed events/roots (dimension: nmaxevents x nztrue, row-major)

Definition at line 74 of file edata.h.

9.6.4.5 nytrue

```
const int nytrue
```

number of observables

Definition at line 77 of file edata.h.

9.6.4.6 nztrue

```
const int nztrue
```

number of event observables

Definition at line 79 of file edata.h.

9.6.4.7 nt

```
const int nt
```

number of timepoints

Definition at line 81 of file edata.h.

9.6.4.8 nmaxevent

```
const int nmaxevent
```

maximal number of event occurences

Definition at line 83 of file edata.h.

9.6.4.9 fixedParameters

```
std::vector<realtype> fixedParameters
```

condition-specific parameters of size Model::nk() or empty

Definition at line 86 of file edata.h.

9.6.4.10 fixedParametersPreequilibration

```
std::vector<realtype> fixedParametersPreequilibration
```

condition-specific parameters for pre-equilibration of size Model::nk() or empty

Definition at line 88 of file edata.h.

9.7 ForwardProblem Class Reference

The ForwardProblem class groups all functions for solving the backwards problem. Has only static members.

```
#include <forwardproblem.h>
```

Collaboration diagram for ForwardProblem:

Public Member Functions

- ForwardProblem (ReturnData *rdata, const ExpData *edata, Model *model, Solver *solver)
- ~ForwardProblem ()
- void workForwardProblem ()
- realtype getTime () const
- AmiVectorArray getStateSensitivity () const
- AmiVectorArray getStatesAtDiscontinuities () const
- AmiVectorArray getRHSAtDiscontinuities () const
- AmiVectorArray getRHSBeforeDiscontinuities () const
- std::vector< int > getNumberOfRoots () const
- std::vector< realtype > getDiscontinuities () const
- std::vector< int > getRootIndexes () const
- std::vector< realtype > getDJydx () const
- std::vector< realtype > getDJzdx () const
- int getRootCounter () const
- AmiVector * getStatePointer ()
- AmiVector * getStateDerivativePointer ()
- AmiVectorArray * getStateSensitivityPointer ()
- AmiVectorArray * getStateDerivativeSensitivityPointer ()

Public Attributes

- Model * model
- ReturnData * rdata
- Solver * solver
- const ExpData * edata

9.7.1 Detailed Description

Definition at line 22 of file forwardproblem.h.

9.7.2 Constructor & Destructor Documentation

9.7.2.1 ForwardProblem()

```
ForwardProblem (
            ReturnData * rdata,
            const ExpData * edata,
            Model * model,
            Solver * solver )
```

default constructor

Parameters

rdata	pointer to ReturnData instance
edata	pointer to ExpData instance
model	pointer to Model instance
solver	pointer to Solver instance

Definition at line 40 of file forwardproblem.cpp.

Here is the call graph for this function:

9.7.2.2 ~ForwardProblem()

```
~ForwardProblem ( )
```

default destructor

Definition at line 27 of file forwardproblem.h.

9.7.3 Member Function Documentation

9.7.3.1 workForwardProblem()

```
void workForwardProblem ( )
```

workForwardProblem solves the forward problem. if forward sensitivities are enabled this will also compute sensitivies

Definition at line 75 of file forwardproblem.cpp.

Here is the call graph for this function:

9.7.3.2 getTime()

```
realtype getTime ( ) const
```

accessor for t

Returns

t

Definition at line 45 of file forwardproblem.h.

Here is the caller graph for this function:

9.7.3.3 getStateSensitivity()

```
AmiVectorArray getStateSensitivity ( ) const
```

accessor for sx

Returns

sx

Definition at line 52 of file forwardproblem.h.

9.7.3.4 getStatesAtDiscontinuities()

```
AmiVectorArray getStatesAtDiscontinuities ( ) const
```

accessor for x_disc

Returns

x_disc

Definition at line 59 of file forwardproblem.h.

9.7.3.5 getRHSAtDiscontinuities()

```
AmiVectorArray getRHSAtDiscontinuities ( ) const
```

accessor for xdot_disc

Returns

xdot_disc

Definition at line 66 of file forwardproblem.h.

9.7.3.6 getRHSBeforeDiscontinuities()

```
AmiVectorArray getRHSBeforeDiscontinuities ( ) const
```

accessor for xdot_old_disc

Returns

xdot_old_disc

Definition at line 73 of file forwardproblem.h.

9.7.3.7 getNumberOfRoots()

```
std::vector<int> getNumberOfRoots ( ) const
```

accessor for nroots

Returns

nroots

Definition at line 80 of file forwardproblem.h.

9.7.3.8 getDiscontinuities()

```
std::vector<realtype> getDiscontinuities ( ) const
```

accessor for discs

Returns

discs

Definition at line 87 of file forwardproblem.h.

9.7.3.9 getRootIndexes()

```
std::vector<int> getRootIndexes ( ) const
```

accessor for rootidx

Returns

rootidx

Definition at line 94 of file forwardproblem.h.

9.7.3.10 getDJydx()

```
std::vector<realtype> getDJydx ( ) const
```

accessor for dJydx

Returns

dJydx

Definition at line 101 of file forwardproblem.h.

9.7.3.11 getDJzdx()

```
std::vector<realtype> getDJzdx ( ) const
```

accessor for dJzdx

Returns

dJzdx

Definition at line 108 of file forwardproblem.h.

9.7.3.12 getRootCounter()

```
int getRootCounter ( ) const
```

accessor for iroot

Returns

iroot

Definition at line 115 of file forwardproblem.h.

Here is the caller graph for this function:

9.7.3.13 getStatePointer()

```
AmiVector* getStatePointer ( )
```

accessor for pointer to x

Returns

&x

Definition at line 122 of file forwardproblem.h.

Here is the caller graph for this function:

9.7.3.14 getStateDerivativePointer()

```
AmiVector* getStateDerivativePointer ( )
```

accessor for pointer to dx

Returns

&dx

Definition at line 129 of file forwardproblem.h.

Here is the caller graph for this function:

9.7.3.15 getStateSensitivityPointer()

```
AmiVectorArray* getStateSensitivityPointer ( )
```

accessor for pointer to sx

Returns

&sx

Definition at line 136 of file forwardproblem.h.

Here is the caller graph for this function:

9.7.3.16 getStateDerivativeSensitivityPointer()

```
AmiVectorArray* getStateDerivativeSensitivityPointer ( )
```

accessor for pointer to sdx

Returns

&sdx

Definition at line 143 of file forwardproblem.h.

Here is the caller graph for this function:

9.7.4 Member Data Documentation

9.7.4.1 model

```
Model* model
```

pointer to model instance

Definition at line 34 of file forwardproblem.h.

9.7.4.2 rdata

```
ReturnData* rdata
```

pointer to return data instance

Definition at line 36 of file forwardproblem.h.

9.7.4.3 solver

```
Solver* solver
```

pointer to solver instance

Definition at line 38 of file forwardproblem.h.

9.7.4.4 edata

```
const ExpData* edata
```

pointer to experimental data instance

Definition at line 40 of file forwardproblem.h.

9.8 IDAException Class Reference

ida exception handler class

```
#include <exception.h>
```

Inheritance diagram for IDAException:

Collaboration diagram for IDAException:

Public Member Functions

- IDAException (const int error_code, const char *function)

9.8.1 Detailed Description

Definition at line 129 of file exception.h.

9.8.2 Constructor & Destructor Documentation

9.8.2.1 IDAException()

```
IDAException (
            const int error_code,
            const char * function )
```

constructor

Parameters

in	*error_code*	error code returned by ida function
in	*function*	ida function name

Definition at line 135 of file exception.h.

9.9 IntegrationFailure Class Reference

integration failure exception this exception should be thrown when an integration failure occured for this exception we can assume that we can recover from the exception and return a solution struct to the user

```
#include <exception.h>
```

Inheritance diagram for IntegrationFailure:

Collaboration diagram for IntegrationFailure:

Public Member Functions

- IntegrationFailure (int code, realtype t)

Public Attributes

- int error_code
- realtype time

9.9.1 Detailed Description

Definition at line 144 of file exception.h.

9.9.2 Constructor & Destructor Documentation

9.9.2.1 IntegrationFailure()

```
IntegrationFailure (
            int code,
            realtype t )
```

constructor

Parameters

in	*code*	error code returned by cvode/ida
in	*t*	time of integration failure

Definition at line 154 of file exception.h.

9.9.3 Member Data Documentation

9.9.3.1 error_code

```
int error_code
```

error code returned by cvode/ida

Definition at line 147 of file exception.h.

9.9.3.2 time

```
realtype time
```

time of integration failure

Definition at line 149 of file exception.h.

9.10 Model Class Reference

The Model class represents an AMICI ODE model. The model can compute various model related quantities based on symbolically generated code.

```
#include <model.h>
```

Inheritance diagram for Model:

Collaboration diagram for Model:

Public Member Functions

- Model ()
- Model (const int nx, const int nxtrue, const int ny, const int nytrue, const int nz, const int nztrue, const int ne, const int nJ, const int nw, const int ndwdx, const int ndwdp, const int nnz, const int ubw, const int lbw, const AMICI_o2mode o2mode, const std::vector< realtype > p, const std::vector< realtype > k, const std::vector< int > plist, const std::vector< realtype > idlist, const std::vector< int > z2event)
- Model & operator= (Model const &other)=delete
- Model (Model const &other)
- virtual Model * clone () const =0

  Clone this instance.
- void initializeVectors ()

  Set the nplist-dependent vectors to their proper sizes.

- virtual std::unique_ptr< Solver > getSolver ()=0
- virtual void froot (realtype t, AmiVector *x, AmiVector *dx, realtype *root)=0
- virtual void fxdot (realtype t, AmiVector *x, AmiVector *dx, AmiVector *xdot)=0
- virtual void fJ (realtype t, realtype cj, AmiVector *x, AmiVector *dx, AmiVector *xdot, DlsMat J)=0
- virtual void fJSparse (realtype t, realtype cj, AmiVector *x, AmiVector *dx, AmiVector *xdot, SlsMat J)=0
- virtual void fJDiag (realtype t, AmiVector *Jdiag, realtype cj, AmiVector *x, AmiVector *dx)=0
- virtual void fdxdotdp (realtype t, AmiVector *x, AmiVector *dx)=0
- virtual void fJv (realtype t, AmiVector *x, AmiVector *dx, AmiVector *xdot, AmiVector *v, AmiVector *nJv, realtype cj)=0
- void fx0 (AmiVector *x)
- virtual void fdx0 (AmiVector *x0, AmiVector *dx0)
- void fsx0 (AmiVectorArray *sx, const AmiVector *x)
- virtual void fsdx0 ()
- void fstau (const realtype t, const int ie, const AmiVector *x, const AmiVectorArray *sx)
- void fy (int it, ReturnData *rdata)
- void fdydp (const int it, ReturnData *rdata)
- void fdydx (const int it, ReturnData *rdata)
- void fz (const int nroots, const int ie, const realtype t, const AmiVector *x, ReturnData *rdata)
- void fsz (const int nroots, const int ie, const realtype t, const AmiVector *x, const AmiVectorArray *sx, ReturnData *rdata)
- void frz (const int nroots, const int ie, const realtype t, const AmiVector *x, ReturnData *rdata)
- void fsrz (const int nroots, const int ie, const realtype t, const AmiVector *x, const AmiVectorArray *sx, ReturnData *rdata)
- void fdzdp (const realtype t, const int ie, const AmiVector *x)
- void fdzdx (const realtype t, const int ie, const AmiVector *x)
- void fdrzdp (const realtype t, const int ie, const AmiVector *x)
- void fdrzdx (const realtype t, const int ie, const AmiVector *x)
- void fdeltax (const int ie, const realtype t, const AmiVector *x, const AmiVector *xdot, const AmiVector *xdot_old)
- void fdeltasx (const int ie, const realtype t, const AmiVector *x, const AmiVectorArray *sx, const AmiVector *xdot, const AmiVector *xdot_old)
- void fdeltaxB (const int ie, const realtype t, const AmiVector *x, const AmiVector *xB, const AmiVector *xdot, const AmiVector *xdot_old)
- void fdeltaqB (const int ie, const realtype t, const AmiVector *x, const AmiVector *xB, const AmiVector *xdot, const AmiVector *xdot_old)
- void fsigma_y (const int it, const ExpData *edata, ReturnData *rdata)
- void fdsigma_ydp (const int it, const ReturnData *rdata)
- void fsigma_z (const realtype t, const int ie, const int *nroots, const ExpData *edata, ReturnData *rdata)
- void fdsigma_zdp (const realtype t)
- void fJy (const int it, ReturnData *rdata, const ExpData *edata)
- void fJz (const int nroots, ReturnData *rdata, const ExpData *edata)
- void fJrz (const int nroots, ReturnData *rdata, const ExpData *edata)
- void fdJydy (const int it, const ReturnData *rdata, const ExpData *edata)
- void fdJydsigma (const int it, const ReturnData *rdata, const ExpData *edata)
- void fdJzdz (const int nroots, const ReturnData *rdata, const ExpData *edata)
- void fdJzdsigma (const int nroots, const ReturnData *rdata, const ExpData *edata)
- void fdJrzdz (const int nroots, const ReturnData *rdata, const ExpData *edata)
- void fdJrzdsigma (const int nroots, const ReturnData *rdata, const ExpData *edata)
- virtual ~Model ()
- void fsy (const int it, ReturnData *rdata)
- void fsz_tf (const int ie, ReturnData *rdata)
- void fsJy (const int it, const std::vector< realtype > dJydx, ReturnData *rdata)
- void fdJydp (const int it, const ExpData *edata, const ReturnData *rdata)
- void fdJydx (std::vector< realtype > *dJydx, const int it, const ExpData *edata, const ReturnData *rdata)
- void fsJz (const int nroots, const std::vector< realtype > dJzdx, AmiVectorArray *sx, ReturnData *rdata)

- void fdJzdp (const int nroots, realtype t, const ExpData *edata, const ReturnData *rdata)
- void fdJzdx (std::vector< realtype > *dJzdx, const int nroots, realtype t, const ExpData *edata, const ReturnData *rdata)
- void initialize (AmiVector *x, AmiVector *dx)
- void initializeStates (AmiVector *x)
- void initHeaviside (AmiVector *x, AmiVector *dx)
- int nplist () const
- int np () const
- int nk () const
- const double * k () const
- int nMaxEvent () const

  Get nmaxevent.
- void setNMaxEvent (int nmaxevent)

  setNMaxEvent
- int nt () const

  Get number of timepoints.
- std::vector< AMICI_parameter_scaling > getParameterScale () const

  getParameterScale
- void setParameterScale (AMICI_parameter_scaling pscale)

  setParameterScale
- void setParameterScale (std::vector< AMICI_parameter_scaling > pscale)

  setParameterScale
- std::vector< int > getPositivityFlag () const

  getPositivityFlag
- void setPositivityFlag (std::vector< int > const &qpositivex)

  setPositivityFlag
- std::vector< realtype > getParameters () const

  getParameters
- void setParameters (std::vector< realtype > const &p)

  setParameters
- std::vector< realtype > getUnscaledParameters () const

  getUnscaledParameters
- std::vector< realtype > getFixedParameters () const

  getFixedParameters
- void setFixedParameters (std::vector< realtype > const &k)

  setFixedParameters
- std::vector< realtype > getTimepoints () const

  getTimepoints
- void setTimepoints (std::vector< realtype > const &ts)

  setTimepoints
- double t (int idx) const

  Get timepoint for given index.
- std::vector< int > getParameterList () const

  getParameterList
- void setParameterList (std::vector< int > const &plist)

  setParameterList
- std::vector< realtype > getInitialStates () const

  getInitialStates
- void setInitialStates (std::vector< realtype > const &x0)

  setInitialStates
- std::vector< realtype > getInitialStateSensitivities () const

getInitialStateSensitivities

- void setInitialStateSensitivities (std::vector< realtype > const &sx0)

  setInitialStateSensitivities
- double t0 () const
- void setT0 (double t0)

  setT0
- int plist (int pos) const
- void unscaleParameters (double *bufferUnscaled) const

  unscaleParameters
- void requireSensitivitiesForAllParameters ()

  Require computation of sensitivities for all parameters p [0..np[in natural order.
- void fw (const realtype t, const N_Vector x)

  Recurring terms in xdot.
- void fdwdp (const realtype t, const N_Vector x)

  Recurring terms in xdot, parameter derivative.
- void fdwdx (const realtype t, const N_Vector x)

  Recurring terms in xdot, state derivative.
- void updateHeaviside (const std::vector< int > rootsfound)
- void updateHeavisideB (const int *rootsfound)
- realtype gett (const int it, const ReturnData *rdata) const
- int checkFinite (const int N, const realtype *array, const char *fun) const

  Check if the given array has only finite elements. If not try to give hints by which other fields this could be caused.

Public Attributes

- const int nx
- const int nxtrue
- const int ny
- const int nytrue
- const int nz
- const int nztrue
- const int ne
- const int nw
- const int ndwdx
- const int ndwdp
- const int nnz
- const int nJ
- const int ubw
- const int lbw
- const AMICI_o2mode o2mode
- const std::vector< int > z2event
- const std::vector< realtype > idlist
- std::vector< realtype > sigmay
- std::vector< realtype > dsigmaydp
- std::vector< realtype > sigmaz
- std::vector< realtype > dsigmazdp
- std::vector< realtype > dJydp
- std::vector< realtype > dJzdp
- std::vector< realtype > deltax
- std::vector< realtype > deltasx
- std::vector< realtype > deltaxB
- std::vector< realtype > deltaqB
- std::vector< realtype > dxdotdp

Protected Member Functions

- virtual void fx0 (realtype *x0, const realtype t, const realtype *p, const realtype *k)
- virtual void fsx0 (realtype *sx0, const realtype t, const realtype *x0, const realtype *p, const realtype *k, const int ip)
- virtual void fstau (realtype *stau, const realtype t, const realtype *x, const realtype *p, const realtype *k, const realtype *h, const realtype *sx, const int ip, const int ie)
- virtual void fy (realtype *y, const realtype t, const realtype *x, const realtype *p, const realtype *k, const realtype *h)
- virtual void fdydp (realtype *dydp, const realtype t, const realtype *x, const realtype *p, const realtype *k, const realtype *h, const int ip)
- virtual void fdydx (realtype *dydx, const realtype t, const realtype *x, const realtype *p, const realtype *k, const realtype *h)
- virtual void fz (realtype *z, const int ie, const realtype t, const realtype *x, const realtype *p, const realtype *k, const realtype *h)
- virtual void fsz (realtype *sz, const int ie, const realtype t, const realtype *x, const realtype *p, const realtype *k, const realtype *h, const realtype *sx, const int ip)
- virtual void frz (realtype *rz, const int ie, const realtype t, const realtype *x, const realtype *p, const realtype *k, const realtype *h)
- virtual void fsrz (realtype *srz, const int ie, const realtype t, const realtype *x, const realtype *p, const realtype *k, const realtype *h, const realtype *sx, const int ip)
- virtual void fdzdp (realtype *dzdp, const int ie, const realtype t, const realtype *x, const realtype *p, const realtype *k, const realtype *h, const int ip)
- virtual void fdzdx (realtype *dzdx, const int ie, const realtype t, const realtype *x, const realtype *p, const realtype *k, const realtype *h)
- virtual void fdrzdp (realtype *drzdp, const int ie, const realtype t, const realtype *x, const realtype *p, const realtype *k, const realtype *h, const int ip)
- virtual void fdrzdx (realtype *drzdx, const int ie, const realtype t, const realtype *x, const realtype *p, const realtype *k, const realtype *h)
- virtual void fdeltax (realtype *deltax, const realtype t, const realtype *x, const realtype *p, const realtype *k, const realtype *h, const int ie, const realtype *xdot, const realtype *xdot_old)
- virtual void fdeltasx (realtype *deltasx, const realtype t, const realtype *x, const realtype *p, const realtype *k, const realtype *h, const realtype *w, const int ip, const int ie, const realtype *xdot, const realtype *xdot_old, const realtype *sx, const realtype *stau)
- virtual void fdeltaxB (realtype *deltaxB, const realtype t, const realtype *x, const realtype *p, const realtype *k, const realtype *h, const int ie, const realtype *xdot, const realtype *xdot_old, const realtype *xB)
- virtual void fdeltaqB (realtype *deltaqB, const realtype t, const realtype *x, const realtype *p, const realtype *k, const realtype *h, const int ip, const int ie, const realtype *xdot, const realtype *xdot_old, const realtype *xB)
- virtual void fsigma_y (realtype *sigmay, const realtype t, const realtype *p, const realtype *k)
- virtual void fdsigma_ydp (realtype *dsigmaydp, const realtype t, const realtype *p, const realtype *k, const int ip)
- virtual void fsigma_z (realtype *sigmaz, const realtype t, const realtype *p, const realtype *k)
- virtual void fdsigma_zdp (realtype *dsigmazdp, const realtype t, const realtype *p, const realtype *k, const int ip)
- virtual void fJy (realtype *nllh, const int iy, const realtype *p, const realtype *k, const realtype *y, const realtype *sigmay, const realtype *my)
- virtual void fJz (realtype *nllh, const int iz, const realtype *p, const realtype *k, const realtype *z, const realtype *sigmaz, const realtype *mz)
- virtual void fJrz (realtype *nllh, const int iz, const realtype *p, const realtype *k, const realtype *z, const realtype *sigmaz)
- virtual void fdJydy (realtype *dJydy, const int iy, const realtype *p, const realtype *k, const realtype *y, const realtype *sigmay, const realtype *my)
- virtual void fdJydsigma (realtype *dJydsigma, const int iy, const realtype *p, const realtype *k, const realtype *y, const realtype *sigmay, const realtype *my)
- virtual void fdJzdz (realtype *dJzdz, const int iz, const realtype *p, const realtype *k, const realtype *z, const realtype *sigmaz, const realtype *mz)

- virtual void fdJzdsigma (realtype *dJzdsigma, const int iz, const realtype *p, const realtype *k, const realtype *z, const realtype *sigmaz, const realtype *mz)
- virtual void fdJrzdz (realtype *dJrzdz, const int iz, const realtype *p, const realtype *k, const realtype *rz, const realtype *sigmaz)
- virtual void fdJrzdsigma (realtype *dJrzdsigma, const int iz, const realtype *p, const realtype *k, const realtype *rz, const realtype *sigmaz)
- virtual void fw (realtype *w, const realtype t, const realtype *x, const realtype *p, const realtype *k, const realtype *h)
- virtual void fdwdp (realtype *dwdp, const realtype t, const realtype *x, const realtype *p, const realtype *k, const realtype *h, const realtype *w)
- virtual void fdwdx (realtype *dwdx, const realtype t, const realtype *x, const realtype *p, const realtype *k, const realtype *h, const realtype *w)
- void getmy (const int it, const ExpData *edata)
- void getmz (const int nroots, const ExpData *edata)
- const realtype * gety (const int it, const ReturnData *rdata) const
- const realtype * getx (const int it, const ReturnData *rdata) const
- const realtype * getsx (const int it, const ReturnData *rdata) const
- const realtype * getz (const int nroots, const ReturnData *rdata) const
- const realtype * getrz (const int nroots, const ReturnData *rdata) const
- const realtype * getsz (const int nroots, const int nplist, const ReturnData *rdata) const
- const realtype * getsrz (const int nroots, const int nplist, const ReturnData *rdata) const

Protected Attributes

- SlsMat J = nullptr
- std::vector< realtype > my
- std::vector< realtype > mz
- std::vector< realtype > dJydy
- std::vector< realtype > dJydsigma
- std::vector< realtype > dJzdz
- std::vector< realtype > dJzdsigma
- std::vector< realtype > dJrzdz
- std::vector< realtype > dJrzdsigma
- std::vector< realtype > dzdx
- std::vector< realtype > dzdp
- std::vector< realtype > drzdx
- std::vector< realtype > drzdp
- std::vector< realtype > dydp
- std::vector< realtype > dydx
- std::vector< realtype > w
- std::vector< realtype > dwdx
- std::vector< realtype > dwdp
- std::vector< realtype > M
- std::vector< realtype > stau
- std::vector< realtype > h
- std::vector< realtype > unscaledParameters
- std::vector< realtype > originalParameters
- std::vector< realtype > fixedParameters
- std::vector< int > plist_
- std::vector< double > x0data
- std::vector< realtype > sx0data
- std::vector< realtype > ts
- std::vector< int > qpositivex
- int nmaxevent = 10
- std::vector< AMICI_parameter_scaling > pscale
- double tstart = 0.0

Friends

- template<class Archive >
  void boost::serialization::serialize (Archive &ar, Model &r, const unsigned int version)

  Serialize Model (see boost::serialization::serialize)
- bool operator== (const Model &a, const Model &b)

  Check equality of data members.

9.10.1 Detailed Description

Definition at line 41 of file model.h.

9.10.2 Constructor & Destructor Documentation

9.10.2.1 Model() [1/3]

```
Model ( )
```

default constructor

Definition at line 44 of file model.h.

9.10.2.2 Model() [2/3]

```
Model (
            const int nx,
            const int nxtrue,
            const int ny,
            const int nytrue,
            const int nz,
            const int nztrue,
            const int ne,
            const int nJ,
            const int nw,
            const int ndwdx,
            const int ndwdp,
            const int nnz,
            const int ubw,
            const int lbw,
            const AMICI_o2mode o2mode,
            const std::vector< realtype > p,
            const std::vector< realtype > k,
            const std::vector< int > plist,
            const std::vector< realtype > idlist,
            const std::vector< int > z2event )
```

constructor with model dimensions

Parameters

nx	number of state variables
nxtrue	number of state variables of the non-augmented model
ny	number of observables
nytrue	number of observables of the non-augmented model
nz	number of event observables
nztrue	number of event observables of the non-augmented model
ne	number of events
nJ	number of objective functions
nw	number of repeating elements
ndwdx	number of nonzero elements in the x derivative of the repeating elements
ndwdp	number of nonzero elements in the p derivative of the repeating elements
nnz	number of nonzero elements in Jacobian
ubw	upper matrix bandwidth in the Jacobian
lbw	lower matrix bandwidth in the Jacobian
o2mode	second order sensitivity mode
p	parameters
k	constants
plist	indexes wrt to which sensitivities are to be computed
idlist	indexes indicating algebraic components (DAE only)
z2event	mapping of event outputs to events

Definition at line 73 of file model.h.

9.10.2.3 Model() [3/3]

```
Model (
            Model const & other )
```

Copy constructor

Parameters

other	object to copy from

Returns

Definition at line 135 of file model.h.

9.10.2.4 ~Model()

```
virtual ~Model ( ) [virtual]
```

default destructor

Definition at line 361 of file model.h.

9.10.3 Member Function Documentation

9.10.3.1 operator=()

```
Model& operator= (
            Model const & other )  [delete]
```

Copy assignment is disabled until const members are removed

Parameters

other	object to copy from

Returns

9.10.3.2 clone()

```
virtual Model* clone ( ) const  [pure virtual]
```

Returns

The clone

9.10.3.3 getSolver()

```
virtual std::unique_ptr<Solver> getSolver ( )  [pure virtual]
```

Retrieves the solver object

Returns

The Solver instance

Implemented in Model_ODE, and Model_DAE.

9.10.3.4 froot()

```
virtual void froot (
            realtype t,
            AmiVector * x,
            AmiVector * dx,
            realtype * root )  [pure virtual]
```

Root function

Parameters

t	time
x	state
dx	time derivative of state (DAE only)
root	array to which values of the root function will be written

Implemented in Model_ODE, and Model_DAE.

Here is the caller graph for this function:

9.10.3.5 fxdot()

```
virtual void fxdot (
            realtype t,
            AmiVector * x,
            AmiVector * dx,
            AmiVector * xdot )  [pure virtual]
```

Residual function

Parameters

t	time
x	state
dx	time derivative of state (DAE only)
xdot	array to which values of the residual function will be written

Implemented in Model_ODE, and Model_DAE.

Here is the caller graph for this function:

9.10.3.6 fJ()

```
virtual void fJ (
            realtype t,
            realtype cj,
            AmiVector * x,
            AmiVector * dx,
            AmiVector * xdot,
            DlsMat J )  [pure virtual]
```

Dense Jacobian function

Parameters

t	time
cj	scaling factor (inverse of timestep, DAE only)
x	state
dx	time derivative of state (DAE only)
xdot	values of residual function (unused)
J	dense matrix to which values of the jacobian will be written

Implemented in Model_ODE, and Model_DAE.

Here is the caller graph for this function:

9.10.3.7 fJSparse()

```
virtual void fJSparse (
            realtype t,
            realtype cj,
            AmiVector * x,
            AmiVector * dx,
            AmiVector * xdot,
            SlsMat J )  [pure virtual]
```

Sparse Jacobian function

Parameters

t	time
cj	scaling factor (inverse of timestep, DAE only)
x	state
dx	time derivative of state (DAE only)
xdot	values of residual function (unused)
J	sparse matrix to which values of the Jacobian will be written

Implemented in Model_ODE, and Model_DAE.

Here is the caller graph for this function:

9.10.3.8 fJDiag()

```
virtual void fJDiag (
            realtype t,
            AmiVector * Jdiag,
            realtype cj,
            AmiVector * x,
            AmiVector * dx )  [pure virtual]
```

Diagonal Jacobian function

Parameters

t	time
Jdiag	array to which the diagonal of the Jacobian will be written
cj	scaling factor (inverse of timestep, DAE only)
x	state
dx	time derivative of state (DAE only)

Returns

flag indicating successful evaluation

Implemented in Model_ODE, and Model_DAE.

Here is the caller graph for this function:

9.10.3.9 fdxdotdp()

```
virtual void fdxdotdp (
            realtype t,
            AmiVector * x,
            AmiVector * dx )  [pure virtual]
```

parameter derivative of residual function

Parameters

t	time
x	state
dx	time derivative of state (DAE only)

Returns

flag indicating successful evaluation

Implemented in Model_ODE, and Model_DAE.

Here is the caller graph for this function:

9.10.3.10 fJv()

```
virtual void fJv (
            realtype t,
            AmiVector * x,
            AmiVector * dx,
            AmiVector * xdot,
            AmiVector * v,
            AmiVector * nJv,
            realtype cj )  [pure virtual]
```

Jacobian multiply function

Parameters

t	time
x	state
dx	time derivative of state (DAE only)
xdot	values of residual function (unused)
v	multiplication vector (unused)
nJv	array to which result of multiplication will be written
cj	scaling factor (inverse of timestep, DAE only)

Implemented in Model_ODE, and Model_DAE.

Here is the caller graph for this function:

9.10.3.11 fx0() [1/2]

```
void fx0 (
            AmiVector * x )
```

Initial states

Parameters

x	pointer to state variables

Definition at line 322 of file model.cpp.

Here is the call graph for this function:

Here is the caller graph for this function:

9.10.3.12 fdx0()

```
virtual void fdx0 (
            AmiVector * x0,
            AmiVector * dx0 )  [virtual]
```

Initial value for time derivative of states (only necessary for DAEs)

Parameters

x0	Vector with the initial states
dx0	Vector to which the initial derivative states will be written (only DAE)

Definition at line 288 of file model.h.

Here is the caller graph for this function:

9.10.3.13 fsx0() [1/2]

```
void fsx0 (
            AmiVectorArray * sx,
            const AmiVector * x )
```

Initial value for initial state sensitivities

Parameters

sx	pointer to state sensitivity variables
x	pointer to state variables

Definition at line 331 of file model.cpp.

Here is the call graph for this function:

Here is the caller graph for this function:

9.10.3.14 fsdx0()

```
virtual void fsdx0 ( ) [virtual]
```

Sensitivity of derivative initial states sensitivities sdx0 (only necessary for DAEs)

Definition at line 295 of file model.h.

Here is the caller graph for this function:

9.10.3.15 fstau() [1/2]

```
void fstau (
            const realtype t,
            const int ie,
            const AmiVector * x,
            const AmiVectorArray * sx )
```

Sensitivity of event timepoint, total derivative

Parameters

t	current timepoint
ie	event index
x	pointer to state variables
sx	pointer to state sensitivity variables

Definition at line 343 of file model.cpp.

Here is the call graph for this function:

9.10.3.16 fy() [1/2]

```
void fy (
            int it,
            ReturnData * rdata )
```

Observables / measurements

Parameters

it	timepoint index
rdata	pointer to return data instance

Definition at line 354 of file model.cpp.

Here is the call graph for this function:

9.10.3.17 fdydp() [1/2]

```
void fdydp (
            const int it,
            ReturnData * rdata )
```

partial derivative of observables y w.r.t. model parameters p

Parameters

it	timepoint index
rdata	pointer to return data instance

Definition at line 362 of file model.cpp.

Here is the call graph for this function:

9.10.3.18 fdydx() [1/2]

```
void fdydx (
            const int it,
            ReturnData * rdata )
```

partial derivative of observables y w.r.t. state variables x

Parameters

it	timepoint index
rdata	pointer to return data instance

Definition at line 373 of file model.cpp.

Here is the call graph for this function:

9.10.3.19 fz() [1/2]

```
void fz (
            const int nroots,
            const int ie,
            const realtype t,
            const AmiVector * x,
            ReturnData * rdata )
```

Event-resolved output

Parameters

nroots	number of events for event index
ie	event index
t	current timepoint
x	current state
rdata	pointer to return data instance

Definition at line 385 of file model.cpp.

Here is the call graph for this function:

9.10.3.20 fsz() [1/2]

```
void fsz (
            const int nroots,
            const int ie,
            const realtype t,
            const AmiVector * x,
            const AmiVectorArray * sx,
            ReturnData * rdata )
```

Sensitivity of z, total derivative

Parameters

nroots	number of events for event index
ie	event index
t	current timepoint
x	current state
sx	current state sensitivities
rdata	pointer to return data instance

Definition at line 397 of file model.cpp.

Here is the call graph for this function:

9.10.3.21 frz() [1/2]

```
void frz (
            const int nroots,
            const int ie,
            const realtype t,
            const AmiVector * x,
            ReturnData * rdata )
```

Event root function of events (equal to froot but does not include non-output events)

Parameters

nroots	number of events for event index
ie	event index
t	current timepoint
x	current state
rdata	pointer to return data instance

Definition at line 411 of file model.cpp.

Here is the call graph for this function:

9.10.3.22 fsrz() [1/2]

```
void fsrz (
            const int nroots,
            const int ie,
            const realtype t,
            const AmiVector * x,
            const AmiVectorArray * sx,
            ReturnData * rdata )
```

Sensitivity of rz, total derivative

Parameters

nroots	number of events for event index
ie	event index
t	current timepoint
x	current state
sx	current state sensitivities
rdata	pointer to return data instance

Definition at line 423 of file model.cpp.

Here is the call graph for this function:

9.10.3.23 fdzdp() [1/2]

```
void fdzdp (
            const realtype t,
            const int ie,
            const AmiVector * x )
```

partial derivative of event-resolved output z w.r.t. to model parameters p

Parameters

ie	event index
t	current timepoint
x	current state

Definition at line 434 of file model.cpp.

Here is the call graph for this function:

9.10.3.24 fdzdx() [1/2]

```
void fdzdx (
            const realtype t,
            const int ie,
            const AmiVector * x )
```

partial derivative of event-resolved output z w.r.t. to model states x

Parameters

ie	event index
t	current timepoint
x	current state

Definition at line 446 of file model.cpp.

Here is the call graph for this function:

9.10.3.25 fdrzdp() [1/2]

```
void fdrzdp (
            const realtype t,
            const int ie,
            const AmiVector * x )
```

Sensitivity of event-resolved root output w.r.t. to model parameters p

Parameters

ie	event index
t	current timepoint
x	current state

Definition at line 456 of file model.cpp.

Here is the call graph for this function:

9.10.3.26 fdrzdx() [1/2]

```
void fdrzdx (
            const realtype t,
            const int ie,
            const AmiVector * x )
```

Sensitivity of event-resolved measurements rz w.r.t. to model states x

Parameters

ie	event index
t	current timepoint
x	current state

Definition at line 468 of file model.cpp.

Here is the call graph for this function:

9.10.3.27 fdeltax() [1/2]

```
void fdeltax (
            const int ie,
            const realtype t,
            const AmiVector * x,
            const AmiVector * xdot,
            const AmiVector * xdot_old )
```

State update functions for events

Parameters

ie	event index
t	current timepoint
x	current state
xdot	current residual function values
xdot_old	value of residual function before event

Definition at line 480 of file model.cpp.

Here is the call graph for this function:

9.10.3.28 fdeltasx() [1/2]

```
void fdeltasx (
            const int ie,
            const realtype t,
            const AmiVector * x,
            const AmiVectorArray * sx,
            const AmiVector * xdot,
            const AmiVector * xdot_old )
```

Sensitivity update functions for events, total derivative

Parameters

ie	event index
t	current timepoint
x	current state
sx	current state sensitivity
xdot	current residual function values
xdot_old	value of residual function before event

Definition at line 494 of file model.cpp.

Here is the call graph for this function:

9.10.3.29 fdeltaxB() [1/2]

```
void fdeltaxB (
            const int ie,
            const realtype t,
            const AmiVector * x,
            const AmiVector * xB,
            const AmiVector * xdot,
            const AmiVector * xdot_old )
```

Adjoint state update functions for events

Parameters

ie	event index
t	current timepoint
x	current state
xB	current adjoint state
xdot	current residual function values
xdot_old	value of residual function before event

Definition at line 511 of file model.cpp.

Here is the call graph for this function:

9.10.3.30 fdeltaqB() [1/2]

```
void fdeltaqB (
            const int ie,
            const realtype t,
            const AmiVector * x,
            const AmiVector * xB,
            const AmiVector * xdot,
            const AmiVector * xdot_old )
```

Quadrature state update functions for events

Parameters

ie	event index
t	current timepoint
x	current state
xB	current adjoint state
xdot	current residual function values
xdot_old	value of residual function before event

Definition at line 525 of file model.cpp.

Here is the call graph for this function:

9.10.3.31 fsigma_y() [1/2]

```
void fsigma_y (
            const int it,
            const ExpData * edata,
            ReturnData * rdata )
```

Standard deviation of measurements

Parameters

it	timepoint index
edata	pointer to experimental data instance
rdata	pointer to return data instance

Definition at line 538 of file model.cpp.

9.10.3.32 fdsigma_ydp() [1/2]

```
void fdsigma_ydp (
            const int it,
            const ReturnData * rdata )
```

partial derivative of standard deviation of measurements w.r.t. model

Parameters

it	timepoint index
rdata	pointer to return data instance

Definition at line 558 of file model.cpp.

9.10.3.33 fsigma_z() [1/2]

```
void fsigma_z (
            const realtype t,
            const int ie,
            const int * nroots,
            const ExpData * edata,
            ReturnData * rdata )
```

Standard deviation of events

Parameters

t	current timepoint
ie	event index
nroots	array with event numbers
edata	pointer to experimental data instance
rdata	pointer to return data instance

Definition at line 571 of file model.cpp.

Here is the call graph for this function:

9.10.3.34 fdsigma_zdp() [1/2]

```
void fdsigma_zdp (
            const realtype t )
```

Sensitivity of standard deviation of events measurements w.r.t. model parameters p

Parameters

t	current timepoint

Definition at line 590 of file model.cpp.

Here is the call graph for this function:

9.10.3.35 fJy() [1/2]

```
void fJy (
            const int it,
            ReturnData * rdata,
            const ExpData * edata )
```

negative log-likelihood of measurements y

Parameters

it	timepoint index
rdata	pointer to return data instance
edata	pointer to experimental data instance

Definition at line 601 of file model.cpp.

Here is the call graph for this function:

9.10.3.36 fJz() [1/2]

```
void fJz (
            const int nroots,
            ReturnData * rdata,
            const ExpData * edata )
```

negative log-likelihood of event-resolved measurements z

Parameters

nroots	event index
rdata	pointer to return data instance
edata	pointer to experimental data instance

Definition at line 618 of file model.cpp.

Here is the call graph for this function:

9.10.3.37 fJrz() [1/2]

```
void fJrz (
            const int nroots,
            ReturnData * rdata,
            const ExpData * edata )
```

regularization of negative log-likelihood with roots of event-resolved measurements rz

Parameters

nroots	event index
rdata	pointer to return data instance
edata	pointer to experimental data instance

Definition at line 636 of file model.cpp.

Here is the call graph for this function:

9.10.3.38 fdJydy() [1/2]

```
void fdJydy (
            const int it,
```

```
const ReturnData * rdata,
const ExpData * edata )
```

partial derivative of time-resolved measurement negative log-likelihood Jy

Parameters

it	timepoint index
rdata	pointer to return data instance
edata	pointer to experimental data instance

Definition at line 653 of file model.cpp.

Here is the call graph for this function:

9.10.3.39 fdJydsigma() [1/2]

```
void fdJydsigma (
            const int it,
            const ReturnData * rdata,
            const ExpData * edata )
```

Sensitivity of time-resolved measurement negative log-likelihood Jy w.r.t. standard deviation sigma

Parameters

it	timepoint index
rdata	pointer to return data instance
edata	pointer to experimental data instance

Definition at line 670 of file model.cpp.

Here is the call graph for this function:

9.10.3.40 fdJzdz() [1/2]

```
void fdJzdz (
            const int nroots,
            const ReturnData * rdata,
            const ExpData * edata )
```

partial derivative of event measurement negative log-likelihood Jz

Parameters

nroots	event index
rdata	pointer to return data instance
edata	pointer to experimental data instance

Definition at line 686 of file model.cpp.

Here is the call graph for this function:

9.10.3.41 fdJzdsigma() [1/2]

```
void fdJzdsigma (
            const int nroots,
            const ReturnData * rdata,
            const ExpData * edata )
```

Sensitivity of event measurement negative log-likelihood Jz w.r.t. standard deviation sigmaz

Parameters

nroots	event index
rdata	pointer to return data instance
edata	pointer to experimental data instance

Definition at line 703 of file model.cpp.

Here is the call graph for this function:

9.10.3.42 fdJrzdz() [1/2]

```
void fdJrzdz (
            const int nroots,
            const ReturnData * rdata,
            const ExpData * edata )
```

partial derivative of event measurement negative log-likelihood Jz

Parameters

nroots	event index
rdata	pointer to return data instance
edata	pointer to experimental data instance

Definition at line 719 of file model.cpp.

Here is the call graph for this function:

9.10.3.43 fdJrzdsigma() [1/2]

```
void fdJrzdsigma (
            const int nroots,
            const ReturnData * rdata,
            const ExpData * edata )
```

Sensitivity of event measurement negative log-likelihood Jz w.r.t. standard deviation sigmaz

Parameters

nroots	event index
rdata	pointer to return data instance
edata	pointer to experimental data instance

Definition at line 736 of file model.cpp.

Here is the call graph for this function:

9.10.3.44 fsy()

```
void fsy (
            const int it,
            ReturnData * rdata )
```

Sensitivity of measurements y, total derivative

Parameters

it	timepoint index
rdata	pointer to return data instance

Definition at line 15 of file model.cpp.

Here is the call graph for this function:

9.10.3.45 fsz_tf()

```
void fsz_tf (
            const int nroots,
            ReturnData * rdata )
```

Sensitivity of z at final timepoint (ignores sensitivity of timepoint), total derivative

Parameters

nroots	event index
rdata	pointer to return data instance

Definition at line 37 of file model.cpp.

Here is the call graph for this function:

9.10.3.46 fsJy()

```
void fsJy (
            const int it,
            const std::vector< realtype > dJydx,
            ReturnData * rdata )
```

Sensitivity of time-resolved measurement negative log-likelihood Jy, total derivative

Parameters

it	timepoint index
dJydx	vector with values of state derivative of Jy
rdata	pointer to return data instance

Definition at line 54 of file model.cpp.

Here is the call graph for this function:

9.10.3.47 fdJydp()

```
void fdJydp (
            const int it,
            const ExpData * edata,
            const ReturnData * rdata )
```

Sensitivity of time-resolved measurement negative log-likelihood Jy w.r.t. parameters

Parameters

it	timepoint index
edata	pointer to experimental data instance
rdata	pointer to return data instance

Definition at line 89 of file model.cpp.

Here is the call graph for this function:

9.10.3.48 fdJydx()

```
void fdJydx (
            std::vector< realtype > * dJydx,
            const int it,
            const ExpData * edata,
            const ReturnData * rdata )
```

Sensitivity of time-resolved measurement negative log-likelihood Jy w.r.t. state variables

Parameters

dJydx	pointer to vector with values of state derivative of Jy
it	timepoint index
edata	pointer to experimental data instance
rdata	pointer to return data instance

Definition at line 118 of file model.cpp.

Here is the call graph for this function:

9.10.3.49 fsJz()

```
void fsJz (
            const int nroots,
            const std::vector< realtype > dJzdx,
            AmiVectorArray * sx,
            ReturnData * rdata )
```

Sensitivity of event-resolved measurement negative log-likelihood Jz, total derivative

Parameters

nroots	event index
dJzdx	vector with values of state derivative of Jz
sx	pointer to state sensitivities
rdata	pointer to return data instance

Definition at line 144 of file model.cpp.

Here is the call graph for this function:

9.10.3.50 fdJzdp()

```
void fdJzdp (
            const int nroots,
            realtype t,
            const ExpData * edata,
            const ReturnData * rdata )
```

Sensitivity of event-resolved measurement negative log-likelihood Jz w.r.t. parameters

Parameters

nroots	event index
t	current timepoint
edata	pointer to experimental data instance
rdata	pointer to return data instance

Definition at line 185 of file model.cpp.

Here is the call graph for this function:

9.10.3.51 fdJzdx()

```
void fdJzdx (
            std::vector< realtype > * dJzdx,
            const int nroots,
            realtype t,
            const ExpData * edata,
            const ReturnData * rdata )
```

Sensitivity of event-resolved measurement negative log-likelihood Jz w.r.t. state variables

Parameters

dJzdx	pointer to vector with values of state derivative of Jz
nroots	event index
t	current timepoint
edata	pointer to experimental data instance
rdata	pointer to return data instance

Definition at line 229 of file model.cpp.

Here is the call graph for this function:

9.10.3.52 initialize()

```
void initialize (
            AmiVector * x,
            AmiVector * dx )
```

initialization of model properties

Parameters

x	pointer to state variables
dx	pointer to time derivative of states (DAE only)

Definition at line 256 of file model.cpp.

Here is the call graph for this function:

Here is the caller graph for this function:

9.10.3.53 initializeStates()

```
void initializeStates (
            AmiVector * x )
```

initialization of initial states

Parameters

x	pointer to state variables

Definition at line 269 of file model.cpp.

Here is the call graph for this function:

Here is the caller graph for this function:

9.10.3.54 initHeaviside()

```
void initHeaviside (
            AmiVector * x,
            AmiVector * dx )
```

initHeaviside initialises the heaviside variables h at the intial time t0 heaviside variables activate/deactivate on event occurences

Parameters

x	pointer to state variables
dx	pointer to time derivative of states (DAE only)

Definition at line 286 of file model.cpp.

Here is the call graph for this function:

Here is the caller graph for this function:

9.10.3.55 nplist()

```
int nplist ( ) const
```

number of paramaeters wrt to which sensitivities are computed

Returns

length of sensitivity index vector

Definition at line 393 of file model.h.

Here is the caller graph for this function:

9.10.3.56 np()

```
int np ( ) const
```

total number of model parameters

Returns

length of parameter vector

Definition at line 399 of file model.h.

Here is the caller graph for this function:

9.10.3.57 nk()

```
int nk ( ) const
```

number of constants

Returns

length of constant vector

Definition at line 405 of file model.h.

Here is the caller graph for this function:

9.10.3.58 k()

```
const double* k ( ) const
```

constants

Returns

pointer to constants array

Definition at line 412 of file model.h.

Here is the caller graph for this function:

9.10.3.59 nMaxEvent()

```
int nMaxEvent ( ) const
```

Returns

nmaxevent

Definition at line 420 of file model.h.

9.10.3.60 setNMaxEvent()

```
void setNMaxEvent (
            int nmaxevent )
```

Parameters

nmaxevent	

Definition at line 428 of file model.h.

9.10.3.61 nt()

```
int nt ( ) const
```

Returns

number of timepoints

Definition at line 436 of file model.h.

Here is the caller graph for this function:

9.10.3.62 getParameterScale()

```
std::vector<AMICI_parameter_scaling> getParameterScale ( ) const
```

Returns

Definition at line 444 of file model.h.

9.10.3.63 setParameterScale() [1/2]

```
void setParameterScale (
            AMICI_parameter_scaling pscale )
```

Parameters

pscale	

Definition at line 452 of file model.h.

Here is the call graph for this function:

9.10.3.64 setParameterScale() [2/2]

```
void setParameterScale (
            std::vector< AMICI_parameter_scaling > pscale )
```

Parameters

pscale	

Definition at line 462 of file model.h.

Here is the call graph for this function:

9.10.3.65 getPositivityFlag()

```
std::vector<int> getPositivityFlag ( ) const
```

Returns

Definition at line 473 of file model.h.

9.10.3.66 setPositivityFlag()

```
void setPositivityFlag (
            std::vector< int > const & qpositivex )
```

Parameters

qpositivex	

Definition at line 481 of file model.h.

9.10.3.67 getParameters()

```
std::vector<realtype> getParameters ( ) const
```

Returns

The user-set parameters (see also getUnscaledParameters)

Definition at line 491 of file model.h.

9.10.3.68 setParameters()

```
void setParameters (
            std::vector< realtype > const & p )
```

Parameters

p	

Definition at line 499 of file model.h.

Here is the call graph for this function:

9.10.3.69 getUnscaledParameters()

```
std::vector<realtype> getUnscaledParameters ( ) const
```

Returns

The unscaled parameters

Definition at line 511 of file model.h.

Here is the caller graph for this function:

9.10.3.70 getFixedParameters()

```
std::vector<realtype> getFixedParameters ( ) const
```

Returns

Definition at line 519 of file model.h.

Here is the caller graph for this function:

9.10.3.71 setFixedParameters()

```
void setFixedParameters (
            std::vector< realtype > const & k )
```

Parameters

k	

Definition at line 527 of file model.h.

Here is the call graph for this function:

Here is the caller graph for this function:

9.10.3.72 getTimepoints()

```
std::vector<realtype> getTimepoints ( ) const
```

Returns

Definition at line 537 of file model.h.

Here is the caller graph for this function:

9.10.3.73 setTimepoints()

```
void setTimepoints (
            std::vector< realtype > const & ts )
```

Parameters

ts	

Definition at line 545 of file model.h.

9.10.3.74 t()

```
double t (
            int idx ) const
```

Parameters

idx	

Returns

Definition at line 554 of file model.h.

Here is the caller graph for this function:

9.10.3.75 getParameterList()

```
std::vector<int> getParameterList ( ) const
```

Returns

Definition at line 562 of file model.h.

Here is the caller graph for this function:

9.10.3.76 setParameterList()

```
void setParameterList (
            std::vector< int > const & plist )
```

Parameters

plist	

Definition at line 570 of file model.h.

Here is the call graph for this function:

9.10.3.77 getInitialStates()

```
std::vector<realtype> getInitialStates ( ) const
```

Returns

Definition at line 583 of file model.h.

9.10.3.78 setInitialStates()

```
void setInitialStates (
            std::vector< realtype > const & x0 )
```

Parameters

x0	

Definition at line 591 of file model.h.

9.10.3.79 getInitialStateSensitivities()

```
std::vector<realtype> getInitialStateSensitivities ( ) const
```

Returns

Definition at line 601 of file model.h.

Here is the caller graph for this function:

9.10.3.80 setInitialStateSensitivities()

```
void setInitialStateSensitivities (
            std::vector< realtype > const & sx0 )
```

Parameters

sx0	

Definition at line 609 of file model.h.

Here is the call graph for this function:

9.10.3.81 t0()

```
double t0 ( ) const
```

initial timepoint

Returns

timepoint

Definition at line 618 of file model.h.

Here is the caller graph for this function:

9.10.3.82 setT0()

```
void setT0 (
            double t0 )
```

Parameters

t0	

Definition at line 626 of file model.h.

Here is the call graph for this function:

9.10.3.83 plist()

```
int plist (
            int pos ) const
```

entry in parameter list

Parameters

pos	index

Returns

entry

Definition at line 634 of file model.h.

Here is the caller graph for this function:

9.10.3.84 unscaleParameters()

```
void unscaleParameters (
            double * bufferUnscaled ) const
```

Parameters

bufferUnscaled	

unscaleParameters removes parameter scaling according to the parameter scaling in pscale

Parameters

out	*bufferUnscaled*	unscaled parameters are written to the array **Type**: double

Returns

status flag indicating success of execution
Type: int

Definition at line 899 of file model.cpp.

Here is the call graph for this function:

Here is the caller graph for this function:

9.10.3.85 fw() [1/2]

```
void fw (
            const realtype t,
            const N_Vector x )
```

Parameters

t	timepoint
x	Vector with the states

Definition at line 751 of file model.cpp.

Here is the call graph for this function:

Here is the caller graph for this function:

9.10.3.86 fdwdp() [1/2]

```
void fdwdp (
            const realtype t,
            const N_Vector x )
```

Parameters

t	timepoint
x	Vector with the states

Definition at line 761 of file model.cpp.

Here is the call graph for this function:

Here is the caller graph for this function:

9.10.3.87 fdwdx() [1/2]

```
void fdwdx (
            const realtype t,
            const N_Vector x )
```

Parameters

t	timepoint
x	Vector with the states

Definition at line 772 of file model.cpp.

Here is the call graph for this function:

Here is the caller graph for this function:

9.10.3.88 updateHeaviside()

```
void updateHeaviside (
            const std::vector< int > rootsfound )
```

updateHeaviside updates the heaviside variables h on event occurences

Parameters

rootsfound	provides the direction of the zero-crossing, so adding it will give the right update to the heaviside variables (zero if no root was found)

Definition at line 728 of file model.h.

9.10.3.89 updateHeavisideB()

```
void updateHeavisideB (
            const int * rootsfound )
```

updateHeavisideB updates the heaviside variables h on event occurences in the backward problem

Parameters

rootsfound	provides the direction of the zero-crossing, so adding it will give the right update to the heaviside variables (zero if no root was found)

Definition at line 742 of file model.h.

9.10.3.90 gett()

```
realtype gett (
            const int it,
            const ReturnData * rdata ) const
```

get current timepoint from index

Parameters

it	timepoint index
rdata	pointer to return data instance

Returns

current timepoint

Definition at line 827 of file model.cpp.

9.10.3.91 checkFinite()

```
int checkFinite (
            const int N,
            const realtype * array,
            const char * fun ) const
```

Parameters

N	
array	
fun	

Returns

AMICI_RECOVERABLE_ERROR if a NaN/Inf value was found, AMICI_SUCCESS otherwise

Definition at line 885 of file model.cpp.

Here is the caller graph for this function:

9.10.3.92 fx0() [2/2]

```
virtual void fx0 (
            realtype * x0,
            const realtype t,
            const realtype * p,
            const realtype * k )  [protected], [virtual]
```

model specific implementation of fx0

Parameters

x0	initial state
t	initial time
p	parameter vector
k	constant vector

Definition at line 785 of file model.h.

9.10.3.93 fsx0() [2/2]

```
virtual void fsx0 (
            realtype * sx0,
            const realtype t,
            const realtype * x0,
            const realtype * p,
            const realtype * k,
            const int ip )  [protected], [virtual]
```

model specific implementation of fsx0

Parameters

sx0	initial state sensitivities
t	initial time
x0	initial state
p	parameter vector
k	constant vector
ip	sensitivity index

Definition at line 797 of file model.h.

9.10.3.94 fstau() [2/2]

```
virtual void fstau (
            realtype * stau,
            const realtype t,
            const realtype * x,
            const realtype * p,
            const realtype * k,
            const realtype * h,
            const realtype * sx,
            const int ip,
            const int ie )  [protected], [virtual]
```

model specific implementation of fstau

Parameters

stau	total derivative of event timepoint
t	current time
x	current state
p	parameter vector
k	constant vector
h	heavyside vector
sx	current state sensitivity
ip	sensitivity index
ie	event index

Definition at line 812 of file model.h.

9.10.3.95 fy() [2/2]

```
virtual void fy (
            realtype * y,
            const realtype t,
            const realtype * x,
            const realtype * p,
            const realtype * k,
            const realtype * h )  [protected], [virtual]
```

model specific implementation of fy

Parameters

y	model output at current timepoint
t	current time
x	current state
p	parameter vector
k	constant vector
h	heavyside vector

Definition at line 824 of file model.h.

9.10.3.96 fdydp() [2/2]

```
virtual void fdydp (
            realtype * dydp,
            const realtype t,
            const realtype * x,
            const realtype * p,
            const realtype * k,
            const realtype * h,
            const int ip )  [protected], [virtual]
```

model specific implementation of fdydp

Parameters

dydp	partial derivative of observables y w.r.t. model parameters p
t	current time
x	current state
p	parameter vector
k	constant vector
h	heavyside vector
ip	parameter index w.r.t. which the derivative is requested

Definition at line 837 of file model.h.

9.10.3.97 fdydx() [2/2]

```
virtual void fdydx (
            realtype * dydx,
            const realtype t,
            const realtype * x,
            const realtype * p,
            const realtype * k,
            const realtype * h )  [protected], [virtual]
```

model specific implementation of fdydx

Parameters

dydx	partial derivative of observables y w.r.t. model states x
t	current time
x	current state
p	parameter vector
k	constant vector
h	heavyside vector

Definition at line 849 of file model.h.

9.10.3.98 fz() [2/2]

```
virtual void fz (
            realtype * z,
            const int ie,
            const realtype t,
            const realtype * x,
            const realtype * p,
            const realtype * k,
            const realtype * h )  [protected], [virtual]
```

model specific implementation of fz

Parameters

z	value of event output
ie	event index
t	current time
x	current state
p	parameter vector
k	constant vector
h	heavyside vector

Definition at line 862 of file model.h.

9.10.3.99 fsz() [2/2]

```
virtual void fsz (
            realtype * sz,
            const int ie,
            const realtype t,
            const realtype * x,
            const realtype * p,
            const realtype * k,
            const realtype * h,
            const realtype * sx,
            const int ip )  [protected], [virtual]
```

model specific implementation of fsz

Parameters

sz	Sensitivity of rz, total derivative
ie	event index
t	current time
x	current state
p	parameter vector
k	constant vector
h	heavyside vector
sx	current state sensitivity
ip	sensitivity index

Definition at line 877 of file model.h.

9.10.3.100 frz() [2/2]

```
virtual void frz (
            realtype * rz,
            const int ie,
            const realtype t,
            const realtype * x,
            const realtype * p,
            const realtype * k,
            const realtype * h )  [protected], [virtual]
```

model specific implementation of frz

Parameters

rz	value of root function at current timepoint (non-output events not included)
ie	event index
t	current time
x	current state
p	parameter vector
k	constant vector
h	heavyside vector

Definition at line 890 of file model.h.

9.10.3.101 fsrz() [2/2]

```
virtual void fsrz (
            realtype * srz,
            const int ie,
            const realtype t,
            const realtype * x,
            const realtype * p,
            const realtype * k,
            const realtype * h,
            const realtype * sx,
            const int ip )  [protected], [virtual]
```

model specific implementation of fsrz

Parameters

srz	Sensitivity of rz, total derivative
ie	event index
t	current time
x	current state
p	parameter vector
k	constant vector
sx	current state sensitivity
h	heavyside vector
ip	sensitivity index

Definition at line 905 of file model.h.

9.10.3.102 fdzdp() [2/2]

```
virtual void fdzdp (
            realtype * dzdp,
            const int ie,
            const realtype t,
            const realtype * x,
            const realtype * p,
            const realtype * k,
            const realtype * h,
            const int ip )  [protected], [virtual]
```

model specific implementation of fdzdp

Parameters

dzdp	partial derivative of event-resolved output z w.r.t. model parameters p
ie	event index
t	current time

Parameters

x	current state
p	parameter vector
k	constant vector
h	heavyside vector
ip	parameter index w.r.t. which the derivative is requested

Definition at line 919 of file model.h.

9.10.3.103 fdzdx() [2/2]

```
virtual void fdzdx (
            realtype * dzdx,
            const int ie,
            const realtype t,
            const realtype * x,
            const realtype * p,
            const realtype * k,
            const realtype * h )  [protected], [virtual]
```

model specific implementation of fdzdx

Parameters

dzdx	partial derivative of event-resolved output z w.r.t. model states x
ie	event index
t	current time
x	current state
p	parameter vector
k	constant vector
h	heavyside vector

Definition at line 932 of file model.h.

9.10.3.104 fdrzdp() [2/2]

```
virtual void fdrzdp (
            realtype * drzdp,
            const int ie,
            const realtype t,
            const realtype * x,
            const realtype * p,
            const realtype * k,
            const realtype * h,
            const int ip )  [protected], [virtual]
```

model specific implementation of fdrzdp

Parameters

drzdp	partial derivative of root output rz w.r.t. model parameters p
ie	event index
t	current time
x	current state
p	parameter vector
k	constant vector
h	heavyside vector
ip	parameter index w.r.t. which the derivative is requested

Definition at line 946 of file model.h.

9.10.3.105 fdrzdx() [2/2]

```
virtual void fdrzdx (
            realtype * drzdx,
            const int ie,
            const realtype t,
            const realtype * x,
            const realtype * p,
            const realtype * k,
            const realtype * h )  [protected], [virtual]
```

model specific implementation of fdrzdx

Parameters

drzdx	partial derivative of root output rz w.r.t. model states x
ie	event index
t	current time
x	current state
p	parameter vector
k	constant vector
h	heavyside vector

Definition at line 959 of file model.h.

9.10.3.106 fdeltax() [2/2]

```
virtual void fdeltax (
            realtype * deltax,
            const realtype t,
            const realtype * x,
            const realtype * p,
            const realtype * k,
            const realtype * h,
            const int ie,
```

```
            const realtype * xdot,
            const realtype * xdot_old )  [protected], [virtual]
```

model specific implementation of fdeltax

Parameters

deltax	state update
t	current time
x	current state
p	parameter vector
k	constant vector
h	heavyside vector
ie	event index
xdot	new model right hand side
xdot_old	previous model right hand side

Definition at line 974 of file model.h.

9.10.3.107 fdeltasx() [2/2]

```
virtual void fdeltasx (
            realtype * deltasx,
            const realtype t,
            const realtype * x,
            const realtype * p,
            const realtype * k,
            const realtype * h,
            const realtype * w,
            const int ip,
            const int ie,
            const realtype * xdot,
            const realtype * xdot_old,
            const realtype * sx,
            const realtype * stau )  [protected], [virtual]
```

model specific implementation of fdeltasx

Parameters

deltasx	sensitivity update
t	current time
x	current state
p	parameter vector
k	constant vector
h	heavyside vector
w	repeating elements vector
ip	sensitivity index
ie	event index
xdot	new model right hand side
xdot_old	previous model right hand side
sx	state sensitivity
stau	event-time sensitivity

Definition at line 994 of file model.h.

9.10.3.108 fdeltaxB() [2/2]

```
virtual void fdeltaxB (
            realtype * deltaxB,
            const realtype t,
            const realtype * x,
            const realtype * p,
            const realtype * k,
            const realtype * h,
            const int ie,
            const realtype * xdot,
            const realtype * xdot_old,
            const realtype * xB )  [protected], [virtual]
```

model specific implementation of fdeltaxB

Parameters

deltaxB	adjoint state update
t	current time
x	current state
p	parameter vector
k	constant vector
h	heavyside vector
ie	event index
xdot	new model right hand side
xdot_old	previous model right hand side
xB	current adjoint state

Definition at line 1012 of file model.h.

9.10.3.109 fdeltaqB() [2/2]

```
virtual void fdeltaqB (
            realtype * deltaqB,
            const realtype t,
            const realtype * x,
            const realtype * p,
            const realtype * k,
            const realtype * h,
            const int ip,
            const int ie,
            const realtype * xdot,
            const realtype * xdot_old,
            const realtype * xB )  [protected], [virtual]
```

model specific implementation of fdeltaqB

Parameters

deltaqB	sensitivity update
t	current time
x	current state
p	parameter vector
k	constant vector
h	heavyside vector
ip	sensitivity index
ie	event index
xdot	new model right hand side
xdot_old	previous model right hand side
xB	adjoint state

Definition at line 1030 of file model.h.

9.10.3.110 fsigma_y() [2/2]

```
virtual void fsigma_y (
            realtype * sigmay,
            const realtype t,
            const realtype * p,
            const realtype * k )  [protected], [virtual]
```

model specific implementation of fsigmay

Parameters

sigmay	standard deviation of measurements
t	current time
p	parameter vector
k	constant vector

Definition at line 1041 of file model.h.

9.10.3.111 fdsigma_ydp() [2/2]

```
virtual void fdsigma_ydp (
            realtype * dsigmaydp,
            const realtype t,
            const realtype * p,
            const realtype * k,
            const int ip )  [protected], [virtual]
```

model specific implementation of fsigmay

Parameters

dsigmaydp	partial derivative of standard deviation of measurements
t	current time
p	parameter vector
k	constant vector
ip	sensitivity index

Definition at line 1052 of file model.h.

9.10.3.112 fsigma_z() [2/2]

```
virtual void fsigma_z (
            realtype * sigmaz,
            const realtype t,
            const realtype * p,
            const realtype * k )  [protected], [virtual]
```

model specific implementation of fsigmaz

Parameters

sigmaz	standard deviation of event measurements
t	current time
p	parameter vector
k	constant vector

Definition at line 1062 of file model.h.

9.10.3.113 fdsigma_zdp() [2/2]

```
virtual void fdsigma_zdp (
            realtype * dsigmazdp,
            const realtype t,
            const realtype * p,
            const realtype * k,
            const int ip )  [protected], [virtual]
```

model specific implementation of fsigmaz

Parameters

dsigmazdp	partial derivative of standard deviation of event measurements
t	current time
p	parameter vector
k	constant vector
ip	sensitivity index

Definition at line 1073 of file model.h.

9.10.3.114 fJy() [2/2]

```
virtual void fJy (
            realtype * nllh,
            const int iy,
            const realtype * p,
            const realtype * k,
            const realtype * y,
            const realtype * sigmay,
            const realtype * my )  [protected], [virtual]
```

model specific implementation of fJy

Parameters

nllh	negative log-likelihood for measurements y
iy	output index
p	parameter vector
k	constant vector
y	model output at timepoint
sigmay	measurement standard deviation at timepoint
my	measurements at timepoint

Definition at line 1086 of file model.h.

9.10.3.115 fJz() [2/2]

```
virtual void fJz (
            realtype * nllh,
            const int iz,
            const realtype * p,
            const realtype * k,
            const realtype * z,
            const realtype * sigmaz,
            const realtype * mz )  [protected], [virtual]
```

model specific implementation of fJz

Parameters

nllh	negative log-likelihood for event measurements z
iz	event output index
p	parameter vector
k	constant vector
z	model event output at timepoint
sigmaz	event measurement standard deviation at timepoint
mz	event measurements at timepoint

Definition at line 1098 of file model.h.

9.10.3.116 fJrz() [2/2]

```
virtual void fJrz (
            realtype * nllh,
            const int iz,
            const realtype * p,
            const realtype * k,
            const realtype * z,
            const realtype * sigmaz )  [protected], [virtual]
```

model specific implementation of fJrz

Parameters

nllh	regularization for event measurements z
iz	event output index
p	parameter vector
k	constant vector
z	model event output at timepoint
sigmaz	event measurement standard deviation at timepoint

Definition at line 1110 of file model.h.

9.10.3.117 fdJydy() [2/2]

```
virtual void fdJydy (
            realtype * dJydy,
            const int iy,
            const realtype * p,
            const realtype * k,
            const realtype * y,
            const realtype * sigmay,
            const realtype * my )  [protected], [virtual]
```

model specific implementation of fdJydy

Parameters

dJydy	partial derivative of time-resolved measurement negative log-likelihood Jy
iy	output index
p	parameter vector
k	constant vector
y	model output at timepoint
sigmay	measurement standard deviation at timepoint
my	measurement at timepoint

Definition at line 1123 of file model.h.

9.10.3.118 fdJydsigma() [2/2]

```
virtual void fdJydsigma (
            realtype * dJydsigma,
            const int iy,
            const realtype * p,
            const realtype * k,
            const realtype * y,
            const realtype * sigmay,
            const realtype * my )  [protected], [virtual]
```

model specific implementation of fdJydsigma

Parameters

dJydsigma	Sensitivity of time-resolved measurement negative log-likelihood Jy w.r.t. standard deviation sigmay
iy	output index
p	parameter vector
k	constant vector
y	model output at timepoint
sigmay	measurement standard deviation at timepoint
my	measurement at timepoint

Definition at line 1138 of file model.h.

9.10.3.119 fdJzdz() [2/2]

```
virtual void fdJzdz (
            realtype * dJzdz,
            const int iz,
            const realtype * p,
            const realtype * k,
            const realtype * z,
            const realtype * sigmaz,
            const realtype * mz )  [protected], [virtual]
```

model specific implementation of fdJzdz

Parameters

dJzdz	partial derivative of event measurement negative log-likelihood Jz
iz	event output index
p	parameter vector
k	constant vector
z	model event output at timepoint
sigmaz	event measurement standard deviation at timepoint
mz	event measurement at timepoint

Definition at line 1152 of file model.h.

9.10.3.120 fdJzdsigma() [2/2]

```
virtual void fdJzdsigma (
            realtype * dJzdsigma,
            const int iz,
            const realtype * p,
            const realtype * k,
            const realtype * z,
            const realtype * sigmaz,
            const realtype * mz )  [protected], [virtual]
```

model specific implementation of fdJzdsigma

Parameters

dJzdsigma	Sensitivity of event measurement negative log-likelihood Jz w.r.t. standard deviation sigmaz
iz	event output index
p	parameter vector
k	constant vector
z	model event output at timepoint
sigmaz	event measurement standard deviation at timepoint
mz	event measurement at timepoint

Definition at line 1167 of file model.h.

9.10.3.121 fdJrzdz() [2/2]

```
virtual void fdJrzdz (
            realtype * dJrzdz,
            const int iz,
            const realtype * p,
            const realtype * k,
            const realtype * rz,
            const realtype * sigmaz )  [protected], [virtual]
```

model specific implementation of fdJrzdz

Parameters

dJrzdz	partial derivative of event penalization Jrz
iz	event output index
p	parameter vector
k	constant vector
rz	model root output at timepoint
sigmaz	event measurement standard deviation at timepoint

Definition at line 1180 of file model.h.

9.10.3.122 fdJrzdsigma() [2/2]

```
virtual void fdJrzdsigma (
            realtype * dJrzdsigma,
            const int iz,
            const realtype * p,
            const realtype * k,
            const realtype * rz,
            const realtype * sigmaz )  [protected], [virtual]
```

model specific implementation of fdJrzdsigma

Parameters

dJrzdsigma	Sensitivity of event penalization Jrz w.r.t. standard deviation sigmaz
iz	event output index
p	parameter vector
k	constant vector
rz	model root output at timepoint
sigmaz	event measurement standard deviation at timepoint

Definition at line 1194 of file model.h.

9.10.3.123 fw() [2/2]

```
virtual void fw (
            realtype * w,
            const realtype t,
            const realtype * x,
            const realtype * p,
            const realtype * k,
            const realtype * h )  [protected], [virtual]
```

model specific implementation of fw

Parameters

w	Recurring terms in xdot
t	timepoint
x	Vector with the states
p	parameter vector
k	constants vector
h	heavyside vector

Definition at line 1207 of file model.h.

9.10.3.124 fdwdp() [2/2]

```
virtual void fdwdp (
            realtype * dwdp,
            const realtype t,
            const realtype * x,
            const realtype * p,
            const realtype * k,
            const realtype * h,
            const realtype * w )  [protected], [virtual]
```

model specific implementation of dwdp

Parameters

dwdp	Recurring terms in xdot, parameter derivative
t	timepoint
x	Vector with the states
p	parameter vector
k	constants vector
h	heavyside vector
w	vector with helper variables

Definition at line 1219 of file model.h.

9.10.3.125 fdwdx() [2/2]

```
virtual void fdwdx (
            realtype * dwdx,
            const realtype t,
            const realtype * x,
            const realtype * p,
            const realtype * k,
            const realtype * h,
            const realtype * w )  [protected], [virtual]
```

model specific implementation of dwdx

Parameters

dwdx	Recurring terms in xdot, state derivative
t	timepoint
x	Vector with the states
p	parameter vector
k	constants vector
h	heavyside vector
w	vector with helper variables

Definition at line 1231 of file model.h.

9.10.3.126 getmy()

```
void getmy (
            const int it,
            const ExpData * edata )  [protected]
```

create my slice at timepoint

Parameters

it	timepoint index
edata	pointer to experimental data instance

Definition at line 782 of file model.cpp.

Here is the caller graph for this function:

9.10.3.127 getmz()

```
void getmz (
            const int nroots,
            const ExpData * edata )  [protected]
```

create mz slice at event

Parameters

nroots	event occurence
edata	pointer to experimental data instance

Definition at line 835 of file model.cpp.

Here is the caller graph for this function:

9.10.3.128 gety()

```
const realtype * gety (
            const int it,
            const ReturnData * rdata ) const  [protected]
```

create y slice at timepoint

Parameters

it	timepoint index
rdata	pointer to return data instance

Returns

y y-slice from rdata instance

Definition at line 817 of file model.cpp.

Here is the caller graph for this function:

9.10.3.129 getx()

```
const realtype * getx (
            const int it,
            const ReturnData * rdata ) const  [protected]
```

create x slice at timepoint

Parameters

it	timepoint index
rdata	pointer to return data instance

Returns

x x-slice from rdata instance

Definition at line 799 of file model.cpp.

Here is the caller graph for this function:

9.10.3.130 getsx()

```
const realtype * getsx (
            const int it,
            const ReturnData * rdata ) const  [protected]
```

create sx slice at timepoint

Parameters

it	timepoint index
rdata	pointer to return data instance

Returns

sx sx-slice from rdata instance

Definition at line 808 of file model.cpp.

Here is the call graph for this function:

Here is the caller graph for this function:

9.10.3.131 getz()

```
const realtype * getz (
            const int nroots,
            const ReturnData * rdata ) const  [protected]
```

create z slice at event

Parameters

nroots	event occurence
rdata	pointer to return data instance

Returns

z slice

Definition at line 852 of file model.cpp.

Here is the caller graph for this function:

9.10.3.132 getrz()

```
const realtype * getrz (
            const int nroots,
            const ReturnData * rdata ) const  [protected]
```

create rz slice at event

Parameters

nroots	event occurence
rdata	pointer to return data instance

Returns

rz slice

Definition at line 861 of file model.cpp.

Here is the caller graph for this function:

9.10.3.133 getsz()

```
const realtype * getsz (
            const int nroots,
            const int ip,
            const ReturnData * rdata ) const  [protected]
```

create sz slice at event

Parameters

nroots	event occurence
ip	sensitivity index
rdata	pointer to return data instance

Returns

z slice

Definition at line 871 of file model.cpp.

Here is the call graph for this function:

9.10.3.134 getsrz()

```
const realtype * getsrz (
            const int nroots,
            const int ip,
            const ReturnData * rdata ) const  [protected]
```

create srz slice at event

Parameters

nroots	event occurence
ip	sensitivity index
rdata	pointer to return data instance

Returns

rz slice

Definition at line 881 of file model.cpp.

Here is the call graph for this function:

9.10.4 Friends And Related Function Documentation

9.10.4.1 boost::serialization::serialize

```
void boost::serialization::serialize (
            Archive & ar,
            Model & r,
            const unsigned int version )  [friend]
```

Parameters

ar	Archive to serialize to
r	Data to serialize
version	Version number

9.10.4.2 operator==

```
bool operator== (
            const Model & a,
            const Model & b )  [friend]
```

Parameters

a	
b	

Returns

Definition at line 925 of file model.cpp.

9.10.5 Member Data Documentation

9.10.5.1 nx

```
const int nx
```

number of states

Definition at line 655 of file model.h.

9.10.5.2 nxtrue

```
const int nxtrue
```

number of states in the unaugmented system

Definition at line 657 of file model.h.

9.10.5.3 ny

```
const int ny
```

number of observables

Definition at line 659 of file model.h.

9.10.5.4 nytrue

```
const int nytrue
```

number of observables in the unaugmented system

Definition at line 661 of file model.h.

9.10.5.5 nz

```
const int nz
```

number of event outputs

Definition at line 663 of file model.h.

9.10.5.6 nztrue

```
const int nztrue
```

number of event outputs in the unaugmented system

Definition at line 665 of file model.h.

9.10.5.7 ne

```
const int ne
```

number of events

Definition at line 667 of file model.h.

9.10.5.8 nw

```
const int nw
```

number of common expressions

Definition at line 669 of file model.h.

9.10.5.9 ndwdx

```
const int ndwdx
```

number of derivatives of common expressions wrt x

Definition at line 671 of file model.h.

9.10.5.10 ndwdp

```
const int ndwdp
```

number of derivatives of common expressions wrt p

Definition at line 673 of file model.h.

9.10.5.11 nnz

```
const int nnz
```

number of nonzero entries in jacobian

Definition at line 675 of file model.h.

9.10.5.12 nJ

```
const int nJ
```

dimension of the augmented objective function for 2nd order ASA

Definition at line 677 of file model.h.

9.10.5.13 ubw

```
const int ubw
```

upper bandwith of the jacobian

Definition at line 679 of file model.h.

9.10.5.14 lbw

```
const int lbw
```

lower bandwith of the jacobian

Definition at line 681 of file model.h.

9.10.5.15 o2mode

```
const AMICI_o2mode o2mode
```

flag indicating whether for sensi == AMICI_SENSI_ORDER_SECOND directional or full second order derivative will be computed

Definition at line 684 of file model.h.

9.10.5.16 z2event

```
const std::vector<int> z2event
```

index indicating to which event an event output belongs

Definition at line 686 of file model.h.

9.10.5.17 idlist

```
const std::vector<realtype> idlist
```

flag array for DAE equations

Definition at line 688 of file model.h.

9.10.5.18 sigmay

```
std::vector<realtype> sigmay
```

data standard deviation

Definition at line 691 of file model.h.

9.10.5.19 dsigmaydp

```
std::vector<realtype> dsigmaydp
```

parameter derivative of data standard deviation

Definition at line 693 of file model.h.

9.10.5.20 sigmaz

```
std::vector<realtype> sigmaz
```

event standard deviation

Definition at line 695 of file model.h.

9.10.5.21 dsigmazdp

```
std::vector<realtype> dsigmazdp
```

parameter derivative of event standard deviation

Definition at line 697 of file model.h.

9.10.5.22 dJydp

```
std::vector<realtype> dJydp
```

parameter derivative of data likelihood

Definition at line 699 of file model.h.

9.10.5.23 dJzdp

```
std::vector<realtype> dJzdp
```

parameter derivative of event likelihood

Definition at line 701 of file model.h.

9.10.5.24 deltax

```
std::vector<realtype> deltax
```

change in x

Definition at line 704 of file model.h.

9.10.5.25 deltasx

```
std::vector<realtype> deltasx
```

change in sx

Definition at line 706 of file model.h.

9.10.5.26 deltaxB

```
std::vector<realtype> deltaxB
```

change in xB

Definition at line 708 of file model.h.

9.10.5.27 deltaqB

```
std::vector<realtype> deltaqB
```

change in qB

Definition at line 710 of file model.h.

9.10.5.28 dxdotdp

```
std::vector<realtype> dxdotdp
```

tempory storage of dxdotdp data across functions

Definition at line 713 of file model.h.

9.10.5.29 J

```
SlsMat J = nullptr  [protected]
```

Jacobian

Definition at line 1253 of file model.h.

9.10.5.30 my

```
std::vector<realtype> my  [protected]
```

current observable

Definition at line 1256 of file model.h.

9.10.5.31 mz

```
std::vector<realtype> mz  [protected]
```

current event measurement

Definition at line 1258 of file model.h.

9.10.5.32 dJydy

```
std::vector<realtype> dJydy  [protected]
```

observable derivative of data likelihood

Definition at line 1260 of file model.h.

9.10.5.33 dJydsigma

```
std::vector<realtype> dJydsigma  [protected]
```

observable sigma derivative of data likelihood

Definition at line 1262 of file model.h.

9.10.5.34 dJzdz

```
std::vector<realtype> dJzdz [protected]
```

event ouput derivative of event likelihood

Definition at line 1264 of file model.h.

9.10.5.35 dJzdsigma

```
std::vector<realtype> dJzdsigma [protected]
```

event sigma derivative of event likelihood

Definition at line 1266 of file model.h.

9.10.5.36 dJrzdz

```
std::vector<realtype> dJrzdz [protected]
```

event ouput derivative of event likelihood at final timepoint

Definition at line 1268 of file model.h.

9.10.5.37 dJrzdsigma

```
std::vector<realtype> dJrzdsigma [protected]
```

event sigma derivative of event likelihood at final timepoint

Definition at line 1270 of file model.h.

9.10.5.38 dzdx

```
std::vector<realtype> dzdx [protected]
```

state derivative of event output

Definition at line 1272 of file model.h.

9.10.5.39 dzdp

```
std::vector<realtype> dzdp [protected]
```

parameter derivative of event output

Definition at line 1274 of file model.h.

9.10.5.40 drzdx

```
std::vector<realtype> drzdx [protected]
```

state derivative of event timepoint

Definition at line 1276 of file model.h.

9.10.5.41 drzdp

```
std::vector<realtype> drzdp [protected]
```

parameter derivative of event timepoint

Definition at line 1278 of file model.h.

9.10.5.42 dydp

```
std::vector<realtype> dydp [protected]
```

parameter derivative of observable

Definition at line 1280 of file model.h.

9.10.5.43 dydx

```
std::vector<realtype> dydx [protected]
```

state derivative of observable

Definition at line 1282 of file model.h.

9.10.5.44 w

```
std::vector<realtype> w  [protected]
```

tempory storage of w data across functions

Definition at line 1284 of file model.h.

9.10.5.45 dwdx

```
std::vector<realtype> dwdx  [protected]
```

tempory storage of dwdx data across functions

Definition at line 1286 of file model.h.

9.10.5.46 dwdp

```
std::vector<realtype> dwdp  [protected]
```

tempory storage of dwdp data across functions

Definition at line 1288 of file model.h.

9.10.5.47 M

```
std::vector<realtype> M  [protected]
```

tempory storage of M data across functions

Definition at line 1290 of file model.h.

9.10.5.48 stau

```
std::vector<realtype> stau  [protected]
```

tempory storage of stau data across functions

Definition at line 1292 of file model.h.

9.10.5.49 h

```
std::vector<realtype> h [protected]
```

flag indicating whether a certain heaviside function should be active or not

Definition at line 1296 of file model.h.

9.10.5.50 unscaledParameters

```
std::vector<realtype> unscaledParameters [protected]
```

unscaled parameters

Definition at line 1299 of file model.h.

9.10.5.51 originalParameters

```
std::vector<realtype> originalParameters [protected]
```

orignal user-provided, possibly scaled parameter array (size np)

Definition at line 1302 of file model.h.

9.10.5.52 fixedParameters

```
std::vector<realtype> fixedParameters [protected]
```

constants

Definition at line 1305 of file model.h.

9.10.5.53 plist_

```
std::vector<int> plist_ [protected]
```

indexes of parameters wrt to which sensitivities are computed

Definition at line 1308 of file model.h.

9.10.5.54 x0data

```
std::vector<double> x0data [protected]
```

state initialisation (size nx)

Definition at line 1311 of file model.h.

9.10.5.55 sx0data

```
std::vector<realtype> sx0data [protected]
```

sensitivity initialisation (size nx $*$ nplist)

Definition at line 1314 of file model.h.

9.10.5.56 ts

```
std::vector<realtype> ts [protected]
```

timepoints (size nt)

Definition at line 1317 of file model.h.

9.10.5.57 qpositivex

```
std::vector<int> qpositivex [protected]
```

positivity flag (size nx)

Definition at line 1320 of file model.h.

9.10.5.58 nmaxevent

```
int nmaxevent = 10 [protected]
```

maximal number of events to track

Definition at line 1323 of file model.h.

9.10.5.59 pscale

```
std::vector<AMICI_parameter_scaling> pscale  [protected]
```

parameter transformation of p

Definition at line 1326 of file model.h.

9.10.5.60 tstart

```
double tstart = 0.0  [protected]
```

starting time

Definition at line 1329 of file model.h.

9.11 Model_DAE Class Reference

The Model class represents an AMICI ODE model. The model does not contain any data, but represents the state of the model at a specific time t. The states must not always be in sync, but may be updated asynchroneously.

```
#include <model_dae.h>
```

Inheritance diagram for Model_DAE:

Collaboration diagram for Model_DAE:

Public Member Functions

- Model_DAE ()
- Model_DAE (const int nx, const int nxtrue, const int ny, const int nytrue, const int nz, const int nztrue, const int ne, const int nJ, const int nw, const int ndwdx, const int ndwdp, const int nnz, const int ubw, const int lbw, const AMICI_o2mode o2mode, const std::vector< realtype > p, const std::vector< realtype > k, const std::vector< int > plist, const std::vector< realtype > idlist, const std::vector< int > z2event)
- virtual void fJ (realtype t, realtype cj, AmiVector *x, AmiVector *dx, AmiVector *xdot, DlsMat J) override
- void fJ (realtype t, realtype cj, N_Vector x, N_Vector dx, N_Vector xdot, DlsMat J)
- void fJB (realtype t, realtype cj, N_Vector x, N_Vector dx, N_Vector xB, N_Vector dxB, DlsMat JB)
- virtual void fJSparse (realtype t, realtype cj, AmiVector *x, AmiVector *dx, AmiVector *xdot, SlsMat J) override
- void fJSparse (realtype t, realtype cj, N_Vector x, N_Vector dx, SlsMat J)
- void fJSparseB (realtype t, realtype cj, N_Vector x, N_Vector dx, N_Vector xB, N_Vector dxB, SlsMat JB)
- virtual void fJDiag (realtype t, AmiVector *JDiag, realtype cj, AmiVector *x, AmiVector *dx) override
- virtual void fJv (realtype t, AmiVector *x, AmiVector *dx, AmiVector *xdot, AmiVector *v, AmiVector *nJv, realtype cj) override
- void fJv (realtype t, N_Vector x, N_Vector dx, N_Vector v, N_Vector Jv, realtype cj)
- void fJvB (realtype t, N_Vector x, N_Vector dx, N_Vector xB, N_Vector dxB, N_Vector vB, N_Vector JvB, realtype cj)
- virtual void froot (realtype t, AmiVector *x, AmiVector *dx, realtype *root) override
- void froot (realtype t, N_Vector x, N_Vector dx, realtype *root)
- virtual void fxdot (realtype t, AmiVector *x, AmiVector *dx, AmiVector *xdot) override
- void fxdot (realtype t, N_Vector x, N_Vector dx, N_Vector xdot)
- void fxBdot (realtype t, N_Vector x, N_Vector dx, N_Vector xB, N_Vector dxB, N_Vector xBdot)
- void fqBdot (realtype t, N_Vector x, N_Vector dx, N_Vector xB, N_Vector dxB, N_Vector qBdot)
- void fdxdotdp (const realtype t, const N_Vector x, const N_Vector dx)
- virtual void fdxdotdp (realtype t, AmiVector *x, AmiVector *dx) override
- void fsxdot (realtype t, N_Vector x, N_Vector dx, int ip, N_Vector sx, N_Vector sdx, N_Vector sxdot)
- void fM (realtype t, const N_Vector x)

  Mass matrix for DAE systems.
- virtual std::unique_ptr< Solver > getSolver () override

Protected Member Functions

- virtual void fJ (realtype *J, const realtype t, const realtype *x, const double *p, const double *k, const realtype *h, const realtype cj, const realtype *dx, const realtype *w, const realtype *dwdx)=0
- virtual void fJB (realtype *JB, const realtype t, const realtype *x, const double *p, const double *k, const realtype *h, const realtype cj, const realtype *xB, const realtype *dx, const realtype *dxB, const realtype *w, const realtype *dwdx)
- virtual void fJSparse (SlsMat JSparse, const realtype t, const realtype *x, const double *p, const double *k, const realtype *h, const realtype cj, const realtype *dx, const realtype *w, const realtype *dwdx)=0
- virtual void fJSparseB (SlsMat JSparseB, const realtype t, const realtype *x, const double *p, const double *k, const realtype *h, const realtype cj, const realtype *xB, const realtype *dx, const realtype *dxB, const realtype *w, const realtype *dwdx)
- virtual void fJDiag (realtype *JDiag, const realtype t, const realtype *x, const realtype *p, const realtype *k, const realtype *h, const realtype cj, const realtype *dx, const realtype *w, const realtype *dwdx)
- virtual void fJv (realtype *Jv, const realtype t, const realtype *x, const double *p, const double *k, const realtype *h, const realtype cj, const realtype *dx, const realtype *v, const realtype *w, const realtype *dwdx)
- virtual void fJvB (realtype *JvB, const realtype t, const realtype *x, const double *p, const double *k, const realtype *h, const realtype cj, const realtype *xB, const realtype *dx, const realtype *dxB, const realtype *vB, const realtype *w, const realtype *dwdx)
- virtual void froot (realtype *root, const realtype t, const realtype *x, const double *p, const double *k, const realtype *h, const realtype *dx)
- virtual void fxdot (realtype *xdot, const realtype t, const realtype *x, const double *p, const double *k, const realtype *h, const realtype *dx, const realtype *w)=0
- virtual void fxBdot (realtype *xBdot, const realtype t, const realtype *x, const double *p, const double *k, const realtype *h, const realtype *xB, const realtype *dx, const realtype *dxB, const realtype *w, const realtype *dwdx)
- virtual void fqBdot (realtype *qBdot, const int ip, const realtype t, const realtype *x, const double *p, const double *k, const realtype *h, const realtype *xB, const realtype *dx, const realtype *dxB, const realtype *w, const realtype *dwdp)
- virtual void fdxdotdp (realtype *dxdotdp, const realtype t, const realtype *x, const realtype *p, const realtype *k, const realtype *h, const int ip, const realtype *dx, const realtype *w, const realtype *dwdp)
- virtual void fsxdot (realtype *sxdot, const realtype t, const realtype *x, const realtype *p, const realtype *k, const realtype *h, const int ip, const realtype *dx, const realtype *sx, const realtype *sdx, const realtype *w, const realtype *dwdx, const realtype *M, const realtype *J, const realtype *dxdotdp)
- virtual void fM (realtype *M, const realtype t, const realtype *x, const realtype *p, const realtype *k)

Additional Inherited Members

9.11.1 Detailed Description

Definition at line 24 of file model_dae.h.

9.11.2 Constructor & Destructor Documentation

9.11.2.1 Model_DAE() [1/2]

```
Model_DAE ( )
```

default constructor

Definition at line 27 of file model_dae.h.

9.11.2.2 Model_DAE() [2/2]

```
Model_DAE (
            const int nx,
            const int nxtrue,
            const int ny,
            const int nytrue,
            const int nz,
            const int nztrue,
            const int ne,
            const int nJ,
            const int nw,
            const int ndwdx,
            const int ndwdp,
            const int nnz,
            const int ubw,
            const int lbw,
            const AMICI_o2mode o2mode,
            const std::vector< realtype > p,
            const std::vector< realtype > k,
            const std::vector< int > plist,
            const std::vector< realtype > idlist,
            const std::vector< int > z2event )
```

constructor with model dimensions

Parameters

nx	number of state variables
nxtrue	number of state variables of the non-augmented model
ny	number of observables
nytrue	number of observables of the non-augmented model
nz	number of event observables
nztrue	number of event observables of the non-augmented model
ne	number of events
nJ	number of objective functions
nw	number of repeating elements
ndwdx	number of nonzero elements in the x derivative of the repeating elements
ndwdp	number of nonzero elements in the p derivative of the repeating elements
nnz	number of nonzero elements in Jacobian
ubw	upper matrix bandwidth in the Jacobian
lbw	lower matrix bandwidth in the Jacobian
o2mode	second order sensitivity mode
p	parameters
k	constants
plist	indexes wrt to which sensitivities are to be computed
idlist	indexes indicating algebraic components (DAE only)
z2event	mapping of event outputs to events

Definition at line 53 of file model_dae.h.

9.11.3 Member Function Documentation

9.11.3.1 fJ() [1/3]

```
void fJ (
            realtype t,
            realtype cj,
            AmiVector * x,
            AmiVector * dx,
            AmiVector * xdot,
            DlsMat J )  [override], [virtual]
```

Dense Jacobian function

Parameters

t	time
cj	scaling factor (inverse of timestep, DAE only)
x	state
dx	time derivative of state (DAE only)
xdot	values of residual function (unused)
J	dense matrix to which values of the jacobian will be written

Implements Model.

Definition at line 6 of file model_dae.cpp.

Here is the call graph for this function:

Here is the caller graph for this function:

9.11.3.2 fJ() [2/3]

```
void fJ (
            realtype t,
            realtype cj,
            N_Vector x,
            N_Vector dx,
            N_Vector xdot,
            DlsMat J )
```

Jacobian of xdot with respect to states x

Parameters

t	timepoint
cj	scaling factor, inverse of the step size
x	Vector with the states
dx	Vector with the derivative states
xdot	Vector with the right hand side
J	Matrix to which the Jacobian will be written

Definition at line 20 of file model_dae.cpp.

Here is the call graph for this function:

9.11.3.3 fJB() [1/2]

```
void fJB (
            realtype t,
            realtype cj,
            N_Vector x,
            N_Vector dx,
            N_Vector xB,
            N_Vector dxB,
            DlsMat JB )
```

Jacobian of xBdot with respect to adjoint state xB

Parameters

t	timepoint
cj	scaling factor, inverse of the step size
x	Vector with the states
dx	Vector with the derivative states
xB	Vector with the adjoint states
dxB	Vector with the adjoint derivative states
JB	Matrix to which the Jacobian will be written

Definition at line 158 of file model_dae.cpp.

Here is the call graph for this function:

9.11.3.4 fJSparse() [1/3]

```
void fJSparse (
            realtype t,
            realtype cj,
            AmiVector * x,
            AmiVector * dx,
            AmiVector * xdot,
            SlsMat J )  [override], [virtual]
```

Sparse Jacobian function

Parameters

t	time
cj	scaling factor (inverse of timestep, DAE only)
x	state
dx	time derivative of state (DAE only)
xdot	values of residual function (unused)
J	sparse matrix to which values of the Jacobian will be written

Implements Model.

Definition at line 28 of file model_dae.cpp.

Here is the call graph for this function:

Here is the caller graph for this function:

9.11.3.5 fJSparse() [2/3]

```
void fJSparse (
            realtype t,
            realtype cj,
            N_Vector x,
            N_Vector dx,
            SlsMat J )
```

J in sparse form (for sparse solvers from the SuiteSparse Package)

Parameters

t	timepoint
cj	scalar in Jacobian (inverse stepsize)
x	Vector with the states
dx	Vector with the derivative states
J	Matrix to which the Jacobian will be written

Definition at line 40 of file model_dae.cpp.

Here is the call graph for this function:

9.11.3.6 fJSparseB() [1/2]

```
void fJSparseB (
            realtype t,
            realtype cj,
            N_Vector x,
            N_Vector dx,
            N_Vector xB,
            N_Vector dxB,
            SlsMat JB )
```

JB in sparse form (for sparse solvers from the SuiteSparse Package)

Parameters

t	timepoint
cj	scalar in Jacobian
x	Vector with the states
dx	Vector with the derivative states
xB	Vector with the adjoint states
dxB	Vector with the adjoint derivative states
JB	Matrix to which the Jacobian will be written

Definition at line 175 of file model_dae.cpp.

Here is the call graph for this function:

9.11.3.7 fJDiag() [1/2]

```
void fJDiag (
            realtype t,
            AmiVector * JDiag,
            realtype cj,
            AmiVector * x,
            AmiVector * dx )  [override], [virtual]
```

diagonalized Jacobian (for preconditioning)

Parameters

t	timepoint
JDiag	Vector to which the Jacobian diagonal will be written
cj	scaling factor, inverse of the step size
x	Vector with the states
dx	Vector with the derivative states

Returns

status flag indicating successful execution

Implements Model.

Definition at line 111 of file model_dae.cpp.

Here is the call graph for this function:

9.11.3.8 fJv() [1/3]

```
void fJv (
            realtype t,
            AmiVector * x,
            AmiVector * dx,
            AmiVector * xdot,
            AmiVector * v,
            AmiVector * nJv,
            realtype cj )  [override], [virtual]
```

Jacobian multiply function

Parameters

t	time
x	state
dx	time derivative of state (DAE only)
xdot	values of residual function (unused)
v	multiplication vector (unused)
nJv	array to which result of multiplication will be written
cj	scaling factor (inverse of timestep, DAE only)

Implements Model.

Definition at line 47 of file model_dae.cpp.

Here is the call graph for this function:

Here is the caller graph for this function:

9.11.3.9 fJv() [2/3]

```
void fJv (
            realtype t,
            N_Vector x,
            N_Vector dx,
            N_Vector v,
            N_Vector Jv,
            realtype cj )
```

Matrix vector product of J with a vector v (for iterative solvers)

Parameters

t	timepoint **Type**: realtype
cj	scaling factor, inverse of the step size
x	Vector with the states
dx	Vector with the derivative states
v	Vector with which the Jacobian is multiplied
Jv	Vector to which the Jacobian vector product will be written

Definition at line 62 of file model_dae.cpp.

Here is the call graph for this function:

9.11.3.10 fJvB() [1/2]

```
void fJvB (
            realtype t,
            N_Vector x,
            N_Vector dx,
            N_Vector xB,
            N_Vector dxB,
            N_Vector vB,
            N_Vector JvB,
            realtype cj )
```

Matrix vector product of JB with a vector v (for iterative solvers)

Parameters

t	timepoint
x	Vector with the states
dx	Vector with the derivative states
xB	Vector with the adjoint states
dxB	Vector with the adjoint derivative states
vB	Vector with which the Jacobian is multiplied
JvB	Vector to which the Jacobian vector product will be written
cj	scalar in Jacobian (inverse stepsize)

Definition at line 194 of file model_dae.cpp.

Here is the call graph for this function:

9.11.3.11 froot() [1/3]

```
void froot (
            realtype t,
            AmiVector * x,
            AmiVector * dx,
            realtype * root )  [override], [virtual]
```

Root function

Parameters

t	time
x	state
dx	time derivative of state (DAE only)
root	array to which values of the root function will be written

Implements Model.

Definition at line 70 of file model_dae.cpp.

Here is the call graph for this function:

Here is the caller graph for this function:

9.11.3.12 froot() [2/3]

```
void froot (
            realtype t,
            N_Vector x,
            N_Vector dx,
            realtype * root )
```

Event trigger function for events

Parameters

t	timepoint
x	Vector with the states
dx	Vector with the derivative states
root	array with root function values

Definition at line 80 of file model_dae.cpp.

Here is the call graph for this function:

9.11.3.13 fxdot() [1/3]

```
void fxdot (
            realtype t,
            AmiVector * x,
            AmiVector * dx,
            AmiVector * xdot )  [override], [virtual]
```

Residual function

Parameters

t	time
x	state
dx	time derivative of state (DAE only)
xdot	array to which values of the residual function will be written

Implements Model.

Definition at line 86 of file model_dae.cpp.

Here is the call graph for this function:

Here is the caller graph for this function:

9.11.3.14 fxdot() [2/3]

```
void fxdot (
            realtype t,
            N_Vector x,
            N_Vector dx,
            N_Vector xdot )
```

residual function of the DAE

Parameters

t	timepoint
x	Vector with the states
dx	Vector with the derivative states
xdot	Vector with the right hand side

Definition at line 96 of file model_dae.cpp.

Here is the call graph for this function:

9.11.3.15 fxBdot() [1/2]

```
void fxBdot (
            realtype t,
            N_Vector x,
            N_Vector dx,
            N_Vector xB,
            N_Vector dxB,
            N_Vector xBdot )
```

Right hand side of differential equation for adjoint state xB

Parameters

t	timepoint
x	Vector with the states
dx	Vector with the derivative states
xB	Vector with the adjoint states
dxB	Vector with the adjoint derivative states
xBdot	Vector with the adjoint right hand side

Definition at line 211 of file model_dae.cpp.

Here is the call graph for this function:

9.11.3.16 fqBdot() [1/2]

```
void fqBdot (
            realtype t,
            N_Vector x,
            N_Vector dx,
            N_Vector xB,
            N_Vector dxB,
            N_Vector qBdot )
```

Right hand side of integral equation for quadrature states qB

Parameters

t	timepoint
x	Vector with the states
dx	Vector with the derivative states
xB	Vector with the adjoint states
dxB	Vector with the adjoint derivative states
qBdot	Vector with the adjoint quadrature right hand side

Definition at line 228 of file model_dae.cpp.

Here is the call graph for this function:

9.11.3.17 fdxdotdp() [1/3]

```
void fdxdotdp (
            const realtype t,
            const N_Vector x,
            const N_Vector dx )
```

Sensitivity of dx/dt wrt model parameters p

Parameters

t	timepoint
x	Vector with the states
dx	Vector with the derivative states

Returns

status flag indicating successful execution

Definition at line 127 of file model_dae.cpp.

Here is the call graph for this function:

Here is the caller graph for this function:

9.11.3.18 fdxdotdp() [2/3]

```
virtual void fdxdotdp (
            realtype t,
            AmiVector * x,
            AmiVector * dx )  [override], [virtual]
```

parameter derivative of residual function

Parameters

t	time
x	state
dx	time derivative of state (DAE only)

Returns

flag indicating successful evaluation

Implements Model.

Definition at line 95 of file model_dae.h.

Here is the call graph for this function:

9.11.3.19 fsxdot() [1/2]

```
void fsxdot (
            realtype t,
            N_Vector x,
            N_Vector dx,
            int ip,
            N_Vector sx,
            N_Vector sdx,
            N_Vector sxdot )
```

Right hand side of differential equation for state sensitivities sx

Parameters

t	timepoint
x	Vector with the states
dx	Vector with the derivative states
ip	parameter index
sx	Vector with the state sensitivities
sdx	Vector with the derivative state sensitivities
sxdot	Vector with the sensitivity right hand side

Definition at line 247 of file model_dae.cpp.

Here is the call graph for this function:

9.11.3.20 fM() [1/2]

```
void fM (
            realtype t,
            const N_Vector x )
```

Parameters

t	timepoint
x	Vector with the states

Definition at line 140 of file model_dae.cpp.

Here is the call graph for this function:

Here is the caller graph for this function:

9.11.3.21 getSolver()

```
std::unique_ptr< Solver > getSolver ( ) [override], [virtual]
```

Retrieves the solver object

Returns

The Solver instance

Implements Model.

Definition at line 145 of file model_dae.cpp.

9.11.3.22 fJ() [3/3]

```
virtual void fJ (
            realtype * J,
            const realtype t,
            const realtype * x,
            const double * p,
            const double * k,
            const realtype * h,
            const realtype cj,
            const realtype * dx,
            const realtype * w,
            const realtype * dwdx )  [protected], [pure virtual]
```

model specific implementation for fJ

Parameters

J	Matrix to which the Jacobian will be written
t	timepoint
x	Vector with the states
p	parameter vector
k	constants vector
h	heavyside vector
cj	scaling factor, inverse of the step size
dx	Vector with the derivative states
w	vector with helper variables
dwdx	derivative of w wrt x

9.11.3.23 fJB() [2/2]

```
virtual void fJB (
            realtype * JB,
            const realtype t,
            const realtype * x,
            const double * p,
            const double * k,
            const realtype * h,
            const realtype cj,
            const realtype * xB,
            const realtype * dx,
            const realtype * dxB,
            const realtype * w,
            const realtype * dwdx )  [protected], [virtual]
```

model specific implementation for fJB

Parameters

JB	Matrix to which the Jacobian will be written
t	timepoint
x	Vector with the states

Parameters

p	parameter vector
k	constants vector
h	heavyside vector
cj	scaling factor, inverse of the step size
xB	Vector with the adjoint states
dx	Vector with the derivative states
dxB	Vector with the adjoint derivative states
w	vector with helper variables
dwdx	derivative of w wrt x

Definition at line 137 of file model_dae.h.

9.11.3.24 fJSparse() [3/3]

```
virtual void fJSparse (
            SlsMat JSparse,
            const realtype t,
            const realtype * x,
            const double * p,
            const double * k,
            const realtype * h,
            const realtype cj,
            const realtype * dx,
            const realtype * w,
            const realtype * dwdx )  [protected], [pure virtual]
```

model specific implementation for fJSparse

Parameters

JSparse	Matrix to which the Jacobian will be written
t	timepoint
x	Vector with the states
p	parameter vector
k	constants vector
h	heavyside vector
cj	scaling factor, inverse of the step size
dx	Vector with the derivative states
w	vector with helper variables
dwdx	derivative of w wrt x

9.11.3.25 fJSparseB() [2/2]

```
virtual void fJSparseB (
            SlsMat JSparseB,
```

```
            const realtype t,
            const realtype * x,
            const double * p,
            const double * k,
            const realtype * h,
            const realtype cj,
            const realtype * xB,
            const realtype * dx,
            const realtype * dxB,
            const realtype * w,
            const realtype * dwdx )  [protected], [virtual]
```

model specific implementation for fJSparseB

Parameters

JSparseB	Matrix to which the Jacobian will be written
t	timepoint
x	Vector with the states
p	parameter vector
k	constants vector
h	heavyside vector
cj	scaling factor, inverse of the step size
xB	Vector with the adjoint states
dx	Vector with the derivative states
dxB	Vector with the adjoint derivative states
w	vector with helper variables
dwdx	derivative of w wrt x

Definition at line 172 of file model_dae.h.

9.11.3.26 fJDiag() [2/2]

```
virtual void fJDiag (
            realtype * JDiag,
            const realtype t,
            const realtype * x,
            const realtype * p,
            const realtype * k,
            const realtype * h,
            const realtype cj,
            const realtype * dx,
            const realtype * w,
            const realtype * dwdx )  [protected], [virtual]
```

model specific implementation for fJDiag

Parameters

JDiag	array to which the Jacobian diagonal will be written
t	timepoint
x	Vector with the states

Parameters

p	parameter vector
k	constants vector
h	heavyside vector
cj	scaling factor, inverse of the step size
dx	Vector with the derivative states
w	vector with helper variables
dwdx	derivative of w wrt x

Definition at line 190 of file model_dae.h.

9.11.3.27 fJv() [3/3]

```
virtual void fJv (
            realtype * Jv,
            const realtype t,
            const realtype * x,
            const double * p,
            const double * k,
            const realtype * h,
            const realtype cj,
            const realtype * dx,
            const realtype * v,
            const realtype * w,
            const realtype * dwdx )  [protected], [virtual]
```

model specific implementation for fJv

Parameters

Jv	Matrix vector product of J with a vector v
t	timepoint
x	Vector with the states
p	parameter vector
k	constants vector
h	heavyside vector
cj	scaling factor, inverse of the step size
dx	Vector with the derivative states
v	Vector with which the Jacobian is multiplied
w	vector with helper variables
dwdx	derivative of w wrt x

Definition at line 208 of file model_dae.h.

9.11.3.28 fJvB() [2/2]

```
virtual void fJvB (
            realtype * JvB,
```

```
            const realtype t,
            const realtype * x,
            const double * p,
            const double * k,
            const realtype * h,
            const realtype cj,
            const realtype * xB,
            const realtype * dx,
            const realtype * dxB,
            const realtype * vB,
            const realtype * w,
            const realtype * dwdx )  [protected], [virtual]
```

model specific implementation for fJvB

Parameters

JvB	Matrix vector product of JB with a vector v
t	timepoint
x	Vector with the states
p	parameter vector
k	constants vector
h	heavyside vector
cj	scaling factor, inverse of the step size
xB	Vector with the adjoint states
dx	Vector with the derivative states
dxB	Vector with the adjoint derivative states
vB	Vector with which the Jacobian is multiplied
w	vector with helper variables
dwdx	derivative of w wrt x

Definition at line 229 of file model_dae.h.

9.11.3.29 froot() [3/3]

```
virtual void froot (
            realtype * root,
            const realtype t,
            const realtype * x,
            const double * p,
            const double * k,
            const realtype * h,
            const realtype * dx )  [protected], [virtual]
```

model specific implementation for froot

Parameters

root	values of the trigger function
t	timepoint
x	Vector with the states
p	parameter vector
k	constants vector
h	heavyside vector
dx	Vector with the derivative states

Definition at line 244 of file model_dae.h.

9.11.3.30 fxdot() [3/3]

```
virtual void fxdot (
            realtype * xdot,
            const realtype t,
            const realtype * x,
            const double * p,
            const double * k,
            const realtype * h,
            const realtype * dx,
            const realtype * w )  [protected], [pure virtual]
```

model specific implementation for fxdot

Parameters

xdot	residual function
t	timepoint
x	Vector with the states
p	parameter vector
k	constants vector
h	heavyside vector
w	vector with helper variables
dx	Vector with the derivative states

9.11.3.31 fxBdot() [2/2]

```
virtual void fxBdot (
            realtype * xBdot,
            const realtype t,
            const realtype * x,
            const double * p,
            const double * k,
            const realtype * h,
            const realtype * xB,
            const realtype * dx,
            const realtype * dxB,
            const realtype * w,
            const realtype * dwdx )  [protected], [virtual]
```

model specific implementation for fxBdot

Parameters

xBdot	adjoint residual function
t	timepoint
x	Vector with the states
p	parameter vector

Parameters

k	constants vector
h	heavyside vector
xB	Vector with the adjoint states
dx	Vector with the derivative states
dxB	Vector with the adjoint derivative states
w	vector with helper variables
dwdx	derivative of w wrt x

Definition at line 275 of file model_dae.h.

9.11.3.32 fqBdot() [2/2]

```
virtual void fqBdot (
            realtype * qBdot,
            const int ip,
            const realtype t,
            const realtype * x,
            const double * p,
            const double * k,
            const realtype * h,
            const realtype * xB,
            const realtype * dx,
            const realtype * dxB,
            const realtype * w,
            const realtype * dwdp )  [protected], [virtual]
```

model specific implementation for fqBdot

Parameters

qBdot	adjoint quadrature equation
ip	sensitivity index
t	timepoint
x	Vector with the states
p	parameter vector
k	constants vector
h	heavyside vector
xB	Vector with the adjoint states
dx	Vector with the derivative states
dxB	Vector with the adjoint derivative states
w	vector with helper variables
dwdp	derivative of w wrt p

Definition at line 295 of file model_dae.h.

9.11.3.33 fdxdotdp() [3/3]

```
virtual void fdxdotdp (
            realtype * dxdotdp,
            const realtype t,
            const realtype * x,
            const realtype * p,
            const realtype * k,
            const realtype * h,
            const int ip,
            const realtype * dx,
            const realtype * w,
            const realtype * dwdp )  [protected], [virtual]
```

model specific implementation of fdxdotdp

Parameters

dxdotdp	partial derivative xdot wrt p
t	timepoint
x	Vector with the states
p	parameter vector
k	constants vector
h	heavyside vector
ip	parameter index
dx	Vector with the derivative states
w	vector with helper variables
dwdp	derivative of w wrt p

Definition at line 313 of file model_dae.h.

9.11.3.34 fsxdot() [2/2]

```
virtual void fsxdot (
            realtype * sxdot,
            const realtype t,
            const realtype * x,
            const realtype * p,
            const realtype * k,
            const realtype * h,
            const int ip,
            const realtype * dx,
            const realtype * sx,
            const realtype * sdx,
            const realtype * w,
            const realtype * dwdx,
            const realtype * M,
            const realtype * J,
            const realtype * dxdotdp )  [protected], [virtual]
```

model specific implementation of fsxdot

Parameters

sxdot	sensitivity rhs
t	timepoint
x	Vector with the states
p	parameter vector
k	constants vector
h	heavyside vector
ip	parameter index
dx	Vector with the derivative states
sx	Vector with the state sensitivities
sdx	Vector with the derivative state sensitivities
w	vector with helper variables
dwdx	derivative of w wrt x
M	mass matrix
J	jacobian
dxdotdp	parameter derivative of residual function

Definition at line 335 of file model_dae.h.

9.11.3.35 fM() [2/2]

```
virtual void fM (
            realtype * M,
            const realtype t,
            const realtype * x,
            const realtype * p,
            const realtype * k )  [protected], [virtual]
```

model specific implementation of fM

Parameters

M	mass matrix
t	timepoint
x	Vector with the states
p	parameter vector
k	constants vector

Definition at line 349 of file model_dae.h.

9.12 Model_ODE Class Reference

The Model class represents an AMICI ODE model. The model does not contain any data, but represents the state of the model at a specific time t. The states must not always be in sync, but may be updated asynchroneously.

```
#include <model_ode.h>
```

Inheritance diagram for Model_ODE:

Collaboration diagram for Model_ODE:

Public Member Functions

- Model_ODE ()
- Model_ODE (const int nx, const int nxtrue, const int ny, const int nytrue, const int nz, const int nztrue, const int ne, const int nJ, const int nw, const int ndwdx, const int ndwdp, const int nnz, const int ubw, const int lbw, const AMICI_o2mode o2mode, const std::vector< realtype > p, const std::vector< realtype > k, const std::vector< int > plist, const std::vector< realtype > idlist, const std::vector< int > z2event)
- Model_ODE (Model_ODE const &other)

  Copy constructor.
- virtual void fJ (realtype t, realtype cj, AmiVector *x, AmiVector *dx, AmiVector *xdot, DlsMat J) override
- void fJ (realtype t, N_Vector x, N_Vector xdot, DlsMat J)
- void fJB (realtype t, N_Vector x, N_Vector xB, N_Vector xBdot, DlsMat JB)
- virtual void fJSparse (realtype t, realtype cj, AmiVector *x, AmiVector *dx, AmiVector *xdot, SlsMat J) override
- void fJSparse (realtype t, N_Vector x, SlsMat J)
- void fJSparseB (realtype t, N_Vector x, N_Vector xB, N_Vector xBdot, SlsMat JB)

- void fJDiag (realtype t, N_Vector JDiag, N_Vector x)
- virtual void fJDiag (realtype t, AmiVector *Jdiag, realtype cj, AmiVector *x, AmiVector *dx) override
- virtual void fJv (realtype t, AmiVector *x, AmiVector *dx, AmiVector *xdot, AmiVector *v, AmiVector *nJv, realtype cj) override
- void fJv (N_Vector v, N_Vector Jv, realtype t, N_Vector x)
- void fJvB (N_Vector vB, N_Vector JvB, realtype t, N_Vector x, N_Vector xB)
- virtual void froot (realtype t, AmiVector *x, AmiVector *dx, realtype *root) override
- void froot (realtype t, N_Vector x, realtype *root)
- virtual void fxdot (realtype t, AmiVector *x, AmiVector *dx, AmiVector *xdot) override
- void fxdot (realtype t, N_Vector x, N_Vector xdot)
- void fxBdot (realtype t, N_Vector x, N_Vector xB, N_Vector xBdot)
- void fqBdot (realtype t, N_Vector x, N_Vector xB, N_Vector qBdot)
- void fdxdotdp (const realtype t, const N_Vector x)
- virtual void fdxdotdp (realtype t, AmiVector *x, AmiVector *dx) override
- void fsxdot (realtype t, N_Vector x, int ip, N_Vector sx, N_Vector sxdot)
- virtual std::unique_ptr< Solver > getSolver () override

Protected Member Functions

- virtual void fJ (realtype *J, const realtype t, const realtype *x, const realtype *p, const realtype *k, const realtype *h, const realtype *w, const realtype *dwdx)=0
- virtual void fJB (realtype *JB, const realtype t, const realtype *x, const realtype *p, const realtype *k, const realtype *h, const realtype *xB, const realtype *w, const realtype *dwdx)
- virtual void fJSparse (SlsMat JSparse, const realtype t, const realtype *x, const realtype *p, const realtype *k, const realtype *h, const realtype *w, const realtype *dwdx)=0
- virtual void fJSparseB (SlsMat JSparseB, const realtype t, const realtype *x, const realtype *p, const realtype *k, const realtype *h, const realtype *xB, const realtype *w, const realtype *dwdx)
- virtual void fJDiag (realtype *JDiag, const realtype t, const realtype *x, const realtype *p, const realtype *k, const realtype *h, const realtype *w, const realtype *dwdx)
- virtual void fJv (realtype *Jv, const realtype t, const realtype *x, const realtype *p, const realtype *k, const realtype *h, const realtype *v, const realtype *w, const realtype *dwdx)
- virtual void fJvB (realtype *JvB, const realtype t, const realtype *x, const realtype *p, const realtype *k, const realtype *h, const realtype *xB, const realtype *vB, const realtype *w, const realtype *dwdx)
- virtual void froot (realtype *root, const realtype t, const realtype *x, const realtype *p, const realtype *k, const realtype *h)
- virtual void fxdot (realtype *xdot, const realtype t, const realtype *x, const realtype *p, const realtype *k, const realtype *h, const realtype *w)=0
- virtual void fxBdot (realtype *xBdot, const realtype t, const realtype *x, const realtype *p, const realtype *k, const realtype *h, const realtype *xB, const realtype *w, const realtype *dwdx)
- virtual void fqBdot (realtype *qBdot, const int ip, const realtype t, const realtype *x, const realtype *p, const realtype *k, const realtype *h, const realtype *xB, const realtype *w, const realtype *dwdp)
- virtual void fdxdotdp (realtype *dxdotdp, const realtype t, const realtype *x, const realtype *p, const realtype *k, const realtype *h, const int ip, const realtype *w, const realtype *dwdp)
- virtual void fsxdot (realtype *sxdot, const realtype t, const realtype *x, const realtype *p, const realtype *k, const realtype *h, const int ip, const realtype *sx, const realtype *w, const realtype *dwdx, const realtype *J, const realtype *dxdotdp)

Additional Inherited Members

9.12.1 Detailed Description

Definition at line 23 of file model_ode.h.

9.12.2 Constructor & Destructor Documentation

9.12.2.1 Model_ODE() [1/3]

```
Model_ODE ( )
```

default constructor

Definition at line 26 of file model_ode.h.

9.12.2.2 Model_ODE() [2/3]

```
Model_ODE (
            const int nx,
            const int nxtrue,
            const int ny,
            const int nytrue,
            const int nz,
            const int nztrue,
            const int ne,
            const int nJ,
            const int nw,
            const int ndwdx,
            const int ndwdp,
            const int nnz,
            const int ubw,
            const int lbw,
            const AMICI_o2mode o2mode,
            const std::vector< realtype > p,
            const std::vector< realtype > k,
            const std::vector< int > plist,
            const std::vector< realtype > idlist,
            const std::vector< int > z2event )
```

constructor with model dimensions

Parameters

nx	number of state variables
nxtrue	number of state variables of the non-augmented model
ny	number of observables
nytrue	number of observables of the non-augmented model
nz	number of event observables
nztrue	number of event observables of the non-augmented model
ne	number of events
nJ	number of objective functions
nw	number of repeating elements
ndwdx	number of nonzero elements in the x derivative of the repeating elements
ndwdp	number of nonzero elements in the p derivative of the repeating elements
nnz	number of nonzero elements in Jacobian
ubw	upper matrix bandwidth in the Jacobian

Parameters

lbw	lower matrix bandwidth in the Jacobian
o2mode	second order sensitivity mode
p	parameters
k	constants
plist	indexes wrt to which sensitivities are to be computed
idlist	indexes indicating algebraic components (DAE only)
z2event	mapping of event outputs to events

Definition at line 52 of file model_ode.h.

9.12.2.3 Model_ODE() [3/3]

```
Model_ODE (
            Model_ODE const & other )
```

Parameters

other	

Definition at line 66 of file model_ode.h.

9.12.3 Member Function Documentation

9.12.3.1 fJ() [1/3]

```
void fJ (
            realtype t,
            realtype cj,
            AmiVector * x,
            AmiVector * dx,
            AmiVector * xdot,
            DlsMat J )  [override], [virtual]
```

Dense Jacobian function

Parameters

t	time
cj	scaling factor (inverse of timestep, DAE only)
x	state
dx	time derivative of state (DAE only)
xdot	values of residual function (unused)
J	dense matrix to which values of the jacobian will be written

Implements Model.

Definition at line 6 of file model_ode.cpp.

Here is the call graph for this function:

Here is the caller graph for this function:

9.12.3.2 fJ() [2/3]

```
void fJ (
            realtype t,
            N_Vector x,
            N_Vector xdot,
            DlsMat J )
```

implementation of fJ at the N_Vector level, this function provides an interface to the model specific routines for the solver implementation aswell as the AmiVector level implementation

Parameters

t	timepoint
x	Vector with the states
xdot	Vector with the right hand side
J	Matrix to which the Jacobian will be written

Definition at line 20 of file model_ode.cpp.

Here is the call graph for this function:

9.12.3.3 fJB() [1/2]

```
void fJB (
            realtype t,
            N_Vector x,
            N_Vector xB,
            N_Vector xBdot,
            DlsMat JB )
```

implementation of fJB at the N_Vector level, this function provides an interface to the model specific routines for the solver implementation

Parameters

t	timepoint
x	Vector with the states
xB	Vector with the adjoint states
xBdot	Vector with the adjoint right hand side
JB	Matrix to which the Jacobian will be written

Definition at line 141 of file model_ode.cpp.

Here is the call graph for this function:

9.12.3.4 fJSparse() [1/3]

```
void fJSparse (
            realtype t,
            realtype cj,
            AmiVector * x,
            AmiVector * dx,
            AmiVector * xdot,
            SlsMat J )  [override], [virtual]
```

Sparse Jacobian function

Parameters

t	time
cj	scaling factor (inverse of timestep, DAE only)
x	state
dx	time derivative of state (DAE only)
xdot	values of residual function (unused)
J	sparse matrix to which values of the Jacobian will be written

Implements Model.

Definition at line 27 of file model_ode.cpp.

Here is the call graph for this function:

Here is the caller graph for this function:

9.12.3.5 fJSparse() [2/3]

```
void fJSparse (
            realtype t,
            N_Vector x,
            SlsMat J )
```

implementation of fJSparse at the N_Vector level, this function provides an interface to the model specific routines for the solver implementation aswell as the AmiVector level implementation

Parameters

t	timepoint
x	Vector with the states
J	Matrix to which the Jacobian will be written

Definition at line 39 of file model_ode.cpp.

Here is the call graph for this function:

9.12.3.6 fJSparseB() [1/2]

```
void fJSparseB (
            realtype t,
            N_Vector x,
            N_Vector xB,
            N_Vector xBdot,
            SlsMat JB )
```

implementation of fJSparseB at the N_Vector level, this function provides an interface to the model specific routines for the solver implementation

Parameters

t	timepoint
x	Vector with the states
xB	Vector with the adjoint states
xBdot	Vector with the adjoint right hand side
JB	Matrix to which the Jacobian will be written

Definition at line 157 of file model_ode.cpp.

Here is the call graph for this function:

9.12.3.7 fJDiag() [1/3]

```
void fJDiag (
            realtype t,
            N_Vector JDiag,
            N_Vector x )
```

implementation of fJDiag at the N_Vector level, this function provides an interface to the model specific routines for the solver implementation

Parameters

t	timepoint
JDiag	Vector to which the Jacobian diagonal will be written
x	Vector with the states

Definition at line 170 of file model_ode.cpp.

Here is the call graph for this function:

Here is the caller graph for this function:

9.12.3.8 fJDiag() [2/3]

```
void fJDiag (
            realtype t,
            AmiVector * JDiag,
            realtype cj,
            AmiVector * x,
            AmiVector * dx )  [override], [virtual]
```

diagonalized Jacobian (for preconditioning)

Parameters

t	timepoint
JDiag	Vector to which the Jacobian diagonal will be written
cj	scaling factor, inverse of the step size
x	Vector with the states
dx	Vector with the derivative states

Returns

status flag indicating successful execution

Implements Model.

Definition at line 109 of file model_ode.cpp.

Here is the call graph for this function:

9.12.3.9 fJv() [1/3]

```
void fJv (
            realtype t,
            AmiVector * x,
            AmiVector * dx,
            AmiVector * xdot,
            AmiVector * v,
            AmiVector * nJv,
            realtype cj )  [override], [virtual]
```

Jacobian multiply function

Parameters

t	time
x	state
dx	time derivative of state (DAE only)
xdot	values of residual function (unused)
v	multiplication vector (unused)
nJv	array to which result of multiplication will be written
cj	scaling factor (inverse of timestep, DAE only)

Implements Model.

Definition at line 46 of file model_ode.cpp.

Here is the call graph for this function:

Here is the caller graph for this function:

9.12.3.10 fJv() [2/3]

```
void fJv (
            N_Vector v,
            N_Vector Jv,
            realtype t,
            N_Vector x )
```

implementation of fJv at the N_Vector level, this function provides an interface to the model specific routines for the solver implementation aswell as the AmiVector level implementation

Parameters

t	timepoint
x	Vector with the states
v	Vector with which the Jacobian is multiplied
Jv	Vector to which the Jacobian vector product will be written

Definition at line 60 of file model_ode.cpp.

Here is the call graph for this function:

9.12.3.11 fJvB() [1/2]

```
void fJvB (
            N_Vector vB,
            N_Vector JvB,
            realtype t,
            N_Vector x,
            N_Vector xB )
```

implementation of fJvB at the N_Vector level, this function provides an interface to the model specific routines for the solver implementation

Parameters

t	timepoint
x	Vector with the states
xB	Vector with the adjoint states
vB	Vector with which the Jacobian is multiplied
JvB	Vector to which the Jacobian vector product will be written

Definition at line 186 of file model_ode.cpp.

Here is the call graph for this function:

9.12.3.12 froot() [1/3]

```
void froot (
            realtype t,
            AmiVector * x,
            AmiVector * dx,
            realtype * root )  [override], [virtual]
```

Root function

Parameters

t	time
x	state
dx	time derivative of state (DAE only)
root	array to which values of the root function will be written

Implements Model.

Definition at line 67 of file model_ode.cpp.

Here is the call graph for this function:

Here is the caller graph for this function:

9.12.3.13 froot() [2/3]

```
void froot (
            realtype t,
            N_Vector x,
            realtype * root )
```

implementation of froot at the N_Vector level, this function provides an interface to the model specific routines for the solver implementation aswell as the AmiVector level implementation

Parameters

t	timepoint
x	Vector with the states
root	array with root function values

Definition at line 78 of file model_ode.cpp.

Here is the call graph for this function:

9.12.3.14 fxdot() [1/3]

```
void fxdot (
            realtype t,
            AmiVector * x,
            AmiVector * dx,
            AmiVector * xdot )  [override], [virtual]
```

Residual function

Parameters

t	time
x	state
dx	time derivative of state (DAE only)
xdot	array to which values of the residual function will be written

Implements Model.

Definition at line 83 of file model_ode.cpp.

Here is the call graph for this function:

9.12.3.15 fxdot() [2/3]

```
void fxdot (
            realtype t,
            N_Vector x,
            N_Vector xdot )
```

implementation of fxdot at the N_Vector level, this function provides an interface to the model specific routines for the solver implementation aswell as the AmiVector level implementation

Parameters

t	timepoint
x	Vector with the states
xdot	Vector with the right hand side

Definition at line 94 of file model_ode.cpp.

Here is the call graph for this function:

Here is the caller graph for this function:

9.12.3.16 fxBdot() [1/2]

```
void fxBdot (
            realtype t,
            N_Vector x,
            N_Vector xB,
            N_Vector xBdot )
```

implementation of fxBdot at the N_Vector level, this function provides an interface to the model specific routines for the solver implementation

Parameters

t	timepoint
x	Vector with the states
xB	Vector with the adjoint states
xBdot	Vector with the adjoint right hand side

Definition at line 200 of file model_ode.cpp.

Here is the call graph for this function:

9.12.3.17 fqBdot() [1/2]

```
void fqBdot (
            realtype t,
            N_Vector x,
            N_Vector xB,
            N_Vector qBdot )
```

implementation of fqBdot at the N_Vector level, this function provides an interface to the model specific routines for the solver implementation

Parameters

t	timepoint
x	Vector with the states
xB	Vector with the adjoint states
qBdot	Vector with the adjoint quadrature right hand side

Definition at line 214 of file model_ode.cpp.

Here is the call graph for this function:

9.12.3.18 fdxdotdp() [1/3]

```
void fdxdotdp (
            const realtype t,
            const N_Vector x )
```

Sensitivity of dx/dt wrt model parameters p

Parameters

t	timepoint
x	Vector with the states

Returns

status flag indicating successful execution

Definition at line 121 of file model_ode.cpp.

Here is the call graph for this function:

Here is the caller graph for this function:

9.12.3.19 fdxdotdp() [2/3]

```
virtual void fdxdotdp (
            realtype t,
            AmiVector * x,
            AmiVector * dx )  [override], [virtual]
```

parameter derivative of residual function

Parameters

t	time
x	state
dx	time derivative of state (DAE only)

Returns

flag indicating successful evaluation

Implements Model.

Definition at line 104 of file model_ode.h.

Here is the call graph for this function:

9.12.3.20 fsxdot() [1/2]

```
void fsxdot (
            realtype t,
            N_Vector x,
            int ip,
            N_Vector sx,
            N_Vector sxdot )
```

implementation of fsxdot at the N_Vector level, this function provides an interface to the model specific routines for the solver implementation

Parameters

t	timepoint
x	Vector with the states
ip	parameter index
sx	Vector with the state sensitivities
sxdot	Vector with the sensitivity right hand side

Definition at line 231 of file model_ode.cpp.

Here is the call graph for this function:

9.12.3.21 getSolver()

```
std::unique_ptr< Solver > getSolver ( ) [override], [virtual]
```

Retrieves the solver object

Returns

The Solver instance

Implements Model.

Definition at line 129 of file model_ode.cpp.

9.12.3.22 fJ() [3/3]

```
virtual void fJ (
            realtype * J,
            const realtype t,
            const realtype * x,
            const realtype * p,
            const realtype * k,
            const realtype * h,
            const realtype * w,
            const realtype * dwdx )  [protected], [pure virtual]
```

model specific implementation for fJ

Parameters

J	Matrix to which the Jacobian will be written
t	timepoint
x	Vector with the states
p	parameter vector
k	constants vector
h	heavyside vector
w	vector with helper variables
dwdx	derivative of w wrt x

9.12.3.23 fJB() [2/2]

```
virtual void fJB (
            realtype * JB,
            const realtype t,
            const realtype * x,
            const realtype * p,
            const realtype * k,
            const realtype * h,
            const realtype * xB,
            const realtype * w,
            const realtype * dwdx )  [protected], [virtual]
```

model specific implementation for fJB

Parameters

JB	Matrix to which the Jacobian will be written
t	timepoint
x	Vector with the states
p	parameter vector
k	constants vector
h	heavyside vector
xB	Vector with the adjoint states
w	vector with helper variables
dwdx	derivative of w wrt x

Definition at line 137 of file model_ode.h.

9.12.3.24 fJSparse() [3/3]

```
virtual void fJSparse (
            SlsMat JSparse,
            const realtype t,
            const realtype * x,
            const realtype * p,
            const realtype * k,
            const realtype * h,
            const realtype * w,
            const realtype * dwdx )  [protected], [pure virtual]
```

model specific implementation for fJSparse

Parameters

JSparse	Matrix to which the Jacobian will be written
t	timepoint
x	Vector with the states
p	parameter vector
k	constants vector
h	heavyside vector
w	vector with helper variables
dwdx	derivative of w wrt x

9.12.3.25 fJSparseB() [2/2]

```
virtual void fJSparseB (
            SlsMat JSparseB,
            const realtype t,
            const realtype * x,
            const realtype * p,
            const realtype * k,
            const realtype * h,
            const realtype * xB,
            const realtype * w,
            const realtype * dwdx )  [protected], [virtual]
```

model specific implementation for fJSparseB

Parameters

JSparseB	Matrix to which the Jacobian will be written
t	timepoint
x	Vector with the states
p	parameter vector
k	constants vector
h	heavyside vector

Parameters

xB	Vector with the adjoint states
w	vector with helper variables
dwdx	derivative of w wrt x

Definition at line 165 of file model_ode.h.

9.12.3.26 fJDiag() [3/3]

```
virtual void fJDiag (
            realtype * JDiag,
            const realtype t,
            const realtype * x,
            const realtype * p,
            const realtype * k,
            const realtype * h,
            const realtype * w,
            const realtype * dwdx )  [protected], [virtual]
```

model specific implementation for fJDiag

Parameters

JDiag	Matrix to which the Jacobian will be written
t	timepoint
x	Vector with the states
p	parameter vector
k	constants vector
h	heavyside vector
w	vector with helper variables
dwdx	derivative of w wrt x

Definition at line 180 of file model_ode.h.

9.12.3.27 fJv() [3/3]

```
virtual void fJv (
            realtype * Jv,
            const realtype t,
            const realtype * x,
            const realtype * p,
            const realtype * k,
            const realtype * h,
            const realtype * v,
            const realtype * w,
            const realtype * dwdx )  [protected], [virtual]
```

model specific implementation for fJv

Parameters

Jv	Matrix vector product of J with a vector v
t	timepoint
x	Vector with the states
p	parameter vector
k	constants vector
h	heavyside vector
v	Vector with which the Jacobian is multiplied
w	vector with helper variables
dwdx	derivative of w wrt x

Definition at line 196 of file model_ode.h.

9.12.3.28 fJvB() [2/2]

```
virtual void fJvB (
            realtype * JvB,
            const realtype t,
            const realtype * x,
            const realtype * p,
            const realtype * k,
            const realtype * h,
            const realtype * xB,
            const realtype * vB,
            const realtype * w,
            const realtype * dwdx )  [protected], [virtual]
```

model specific implementation for fJvB

Parameters

JvB	Matrix vector product of JB with a vector v
t	timepoint
x	Vector with the states
p	parameter vector
k	constants vector
h	heavyside vector
xB	Vector with the adjoint states
vB	Vector with which the Jacobian is multiplied
w	vector with helper variables
dwdx	derivative of w wrt x

Definition at line 213 of file model_ode.h.

9.12.3.29 froot() [3/3]

```
virtual void froot (
            realtype * root,
```

```
            const realtype t,
            const realtype * x,
            const realtype * p,
            const realtype * k,
            const realtype * h )  [protected], [virtual]
```

model specific implementation for froot

Parameters

root	values of the trigger function
t	timepoint
x	Vector with the states
p	parameter vector
k	constants vector
h	heavyside vector

Definition at line 226 of file model_ode.h.

9.12.3.30 fxdot() [3/3]

```
virtual void fxdot (
            realtype * xdot,
            const realtype t,
            const realtype * x,
            const realtype * p,
            const realtype * k,
            const realtype * h,
            const realtype * w )  [protected], [pure virtual]
```

model specific implementation for fxdot

Parameters

xdot	residual function
t	timepoint
x	Vector with the states
p	parameter vector
k	constants vector
h	heavyside vector
w	vector with helper variables

9.12.3.31 fxBdot() [2/2]

```
virtual void fxBdot (
            realtype * xBdot,
            const realtype t,
            const realtype * x,
```

```
            const realtype * p,
            const realtype * k,
            const realtype * h,
            const realtype * xB,
            const realtype * w,
            const realtype * dwdx )  [protected], [virtual]
```

model specific implementation for fxBdot

Parameters

xBdot	adjoint residual function
t	timepoint
x	Vector with the states
p	parameter vector
k	constants vector
h	heavyside vector
xB	Vector with the adjoint states
w	vector with helper variables
dwdx	derivative of w wrt x

Definition at line 252 of file model_ode.h.

9.12.3.32 fqBdot() [2/2]

```
virtual void fqBdot (
            realtype * qBdot,
            const int ip,
            const realtype t,
            const realtype * x,
            const realtype * p,
            const realtype * k,
            const realtype * h,
            const realtype * xB,
            const realtype * w,
            const realtype * dwdp )  [protected], [virtual]
```

model specific implementation for fqBdot

Parameters

qBdot	adjoint quadrature equation
ip	sensitivity index
t	timepoint
x	Vector with the states
p	parameter vector
k	constants vector
h	heavyside vector
xB	Vector with the adjoint states
w	vector with helper variables
dwdp	derivative of w wrt p

Definition at line 269 of file model_ode.h.

9.12.3.33 fdxdotdp() [3/3]

```
virtual void fdxdotdp (
            realtype * dxdotdp,
            const realtype t,
            const realtype * x,
            const realtype * p,
            const realtype * k,
            const realtype * h,
            const int ip,
            const realtype * w,
            const realtype * dwdp )  [protected], [virtual]
```

model specific implementation of fdxdotdp

Parameters

dxdotdp	partial derivative xdot wrt p
t	timepoint
x	Vector with the states
p	parameter vector
k	constants vector
h	heavyside vector
ip	parameter index
w	vector with helper variables
dwdp	derivative of w wrt p

Definition at line 285 of file model_ode.h.

9.12.3.34 fsxdot() [2/2]

```
virtual void fsxdot (
            realtype * sxdot,
            const realtype t,
            const realtype * x,
            const realtype * p,
            const realtype * k,
            const realtype * h,
            const int ip,
            const realtype * sx,
            const realtype * w,
            const realtype * dwdx,
            const realtype * J,
            const realtype * dxdotdp )  [protected], [virtual]
```

model specific implementation of fsxdot

Parameters

sxdot	sensitivity rhs
t	timepoint
x	Vector with the states
p	parameter vector
k	constants vector
h	heavyside vector
ip	parameter index
sx	Vector with the state sensitivities
w	vector with helper variables
dwdx	derivative of w wrt x
J	jacobian
dxdotdp	parameter derivative of residual function

Definition at line 304 of file model_ode.h.

9.13 NewtonFailure Class Reference

newton failure exception this exception should be thrown when the steady state computation failed to converge for this exception we can assume that we can recover from the exception and return a solution struct to the user

```
#include <exception.h>
```

Inheritance diagram for NewtonFailure:

Collaboration diagram for NewtonFailure:

Public Member Functions

- NewtonFailure (const char *msg)

9.13.1 Detailed Description

Definition at line 179 of file exception.h.

9.13.2 Constructor & Destructor Documentation

9.13.2.1 NewtonFailure()

```
NewtonFailure (
            const char * msg )
```

constructor, simply calls AmiException constructor

Parameters

in	*msg*	

Definition at line 184 of file exception.h.

9.14 NewtonSolver Class Reference

The NewtonSolver class sets up the linear solver for the Newton method.

```
#include <newton_solver.h>
```

Inheritance diagram for NewtonSolver:

Collaboration diagram for NewtonSolver:

Public Member Functions

- NewtonSolver (realtype ∗t, AmiVector ∗x, Model ∗model, ReturnData ∗rdata)
- void getStep (int ntry, int nnewt, AmiVector ∗delta)
- void getSensis (const int it, AmiVectorArray ∗sx)
- virtual void prepareLinearSystem (int ntry, int nnewt)=0
- virtual void solveLinearSystem (AmiVector ∗rhs)=0

Static Public Member Functions

- static NewtonSolver ∗ getSolver (realtype ∗t, AmiVector ∗x, int linsolType, Model ∗model, ReturnData ∗rdata, int maxlinsteps, int maxsteps, double atol, double rtol)

Public Attributes

- int maxlinsteps = 0
- int maxsteps = 0
- double atol = 1e-16
- double rtol = 1e-8

Protected Attributes

- realtype * t
- Model * model
- ReturnData * rdata
- AmiVector xdot
- AmiVector * x
- AmiVector dx

9.14.1 Detailed Description

Definition at line 22 of file newton_solver.h.

9.14.2 Constructor & Destructor Documentation

9.14.2.1 NewtonSolver()

```
NewtonSolver (
            realtype * t,
            AmiVector * x,
            Model * model,
            ReturnData * rdata )
```

default constructor, initializes all members with the provided objects

Parameters

t	pointer to time variable
x	pointer to state variables
model	pointer to the AMICI model object
rdata	pointer to the return data object

Definition at line 18 of file newton_solver.cpp.

9.14.3 Member Function Documentation

9.14.3.1 getSolver()

```
NewtonSolver * getSolver (
            realtype * t,
            AmiVector * x,
            int linsolType,
            Model * model,
            ReturnData * rdata,
            int maxlinsteps,
            int maxsteps,
            double atol,
            double rtol )  [static]
```

Tries to determine the steady state of the ODE system by a Newton solver, uses forward intergration, if the Newton solver fails, restarts Newton solver, if integration fails. Computes steady state sensitivities

Parameters

t	pointer to time variable
x	pointer to state variables
linsolType	integer indicating which linear solver to use
model	pointer to the AMICI model object
rdata	pointer to the return data object
maxlinsteps	maximum number of allowed linear steps per Newton step for steady state computation
maxsteps	maximum number of allowed Newton steps for steady state computation
atol	absolute tolerance
rtol	relative tolerance

Returns

solver NewtonSolver according to the specified linsolType

Definition at line 36 of file newton_solver.cpp.

Here is the caller graph for this function:

9.14.3.2 getStep()

```
void getStep (
            int ntry,
            int nnewt,
            AmiVector * delta )
```

Computes the solution of one Newton iteration

Parameters

ntry	integer newton_try integer start number of Newton solver (1 or 2)
nnewt	integer number of current Newton step
delta	containing the RHS of the linear system, will be overwritten by solution to the linear system

Definition at line 107 of file newton_solver.cpp.

Here is the call graph for this function:

Here is the caller graph for this function:

9.14.3.3 getSensis()

```
void getSensis (
            const int it,
            AmiVectorArray * sx )
```

Computes steady state sensitivities

Parameters

it	integer index of current time step
sx	pointer to state variable sensitivities

Definition at line 127 of file newton_solver.cpp.

Here is the call graph for this function:

9.14.3.4 prepareLinearSystem()

```
virtual void prepareLinearSystem (
            int ntry,
            int nnewt )  [pure virtual]
```

Writes the Jacobian for the Newton iteration and passes it to the linear solver

Parameters

ntry	integer newton_try integer start number of Newton solver (1 or 2)
nnewt	integer number of current Newton step

Implemented in NewtonSolverIterative, NewtonSolverSparse, and NewtonSolverDense.

Here is the caller graph for this function:

9.14.3.5 solveLinearSystem()

```
virtual void solveLinearSystem (
            AmiVector * rhs )  [pure virtual]
```

Solves the linear system for the Newton step

Parameters

rhs	containing the RHS of the linear system, will be overwritten by solution to the linear system

Implemented in NewtonSolverIterative, NewtonSolverSparse, and NewtonSolverDense.

Here is the caller graph for this function:

9.14.4 Member Data Documentation

9.14.4.1 maxlinsteps

```
int maxlinsteps = 0
```

maximum number of allowed linear steps per Newton step for steady state computation

Definition at line 56 of file newton_solver.h.

9.14.4.2 maxsteps

```
int maxsteps = 0
```

maximum number of allowed Newton steps for steady state computation

Definition at line 58 of file newton_solver.h.

9.14.4.3 atol

```
double atol = 1e-16
```

absolute tolerance

Definition at line 60 of file newton_solver.h.

9.14.4.4 rtol

```
double rtol = 1e-8
```

relative tolerance

Definition at line 62 of file newton_solver.h.

9.14.4.5 t

```
realtype* t  [protected]
```

time variable

Definition at line 66 of file newton_solver.h.

9.14.4.6 model

```
Model* model  [protected]
```

pointer to the AMICI model object

Definition at line 68 of file newton_solver.h.

9.14.4.7 rdata

```
ReturnData* rdata  [protected]
```

pointer to the return data object

Definition at line 70 of file newton_solver.h.

9.14.4.8 xdot

```
AmiVector xdot  [protected]
```

right hand side AmiVector

Definition at line 72 of file newton_solver.h.

9.14.4.9 x

```
AmiVector* x [protected]
```

current state

Definition at line 74 of file newton_solver.h.

9.14.4.10 dx

```
AmiVector dx [protected]
```

current state time derivative (DAE)

Definition at line 76 of file newton_solver.h.

9.15 NewtonSolverDense Class Reference

The NewtonSolverDense provides access to the dense linear solver for the Newton method.

```
#include <newton_solver.h>
```

Inheritance diagram for NewtonSolverDense:

Collaboration diagram for NewtonSolverDense:

Public Member Functions

- NewtonSolverDense (realtype ∗t, AmiVector ∗x, Model ∗model, ReturnData ∗rdata)
- void solveLinearSystem (AmiVector ∗rhs) override
- void prepareLinearSystem (int ntry, int nnewt) override

Additional Inherited Members

9.15.1 Detailed Description

Definition at line 85 of file newton_solver.h.

9.15.2 Constructor & Destructor Documentation

9.15.2.1 NewtonSolverDense()

```
NewtonSolverDense (
            realtype * t,
            AmiVector * x,
            Model * model,
            ReturnData * rdata )
```

default constructor, initializes all members with the provided objects and initializes temporary storage objects

Parameters

t	pointer to time variable
x	pointer to state variables
model	pointer to the AMICI model object
rdata	pointer to the return data object

Definition at line 161 of file newton_solver.cpp.

9.15.3 Member Function Documentation

9.15.3.1 solveLinearSystem()

```
void solveLinearSystem (
            AmiVector * rhs )  [override], [virtual]
```

Solves the linear system for the Newton step

Parameters

rhs	containing the RHS of the linear system, will be overwritten by solution to the linear system

Solves the linear system for the Newton step

Parameters

rhs	containing the RHS of the linear system, will be overwritten by solution to the linear system

Implements NewtonSolver.

Definition at line 200 of file newton_solver.cpp.

Here is the call graph for this function:

9.15.3.2 prepareLinearSystem()

```
void prepareLinearSystem (
            int ntry,
            int nnewt )  [override], [virtual]
```

Writes the Jacobian for the Newton iteration and passes it to the linear solver

Parameters

ntry	integer newton_try integer start number of Newton solver (1 or 2)
nnewt	integer number of current Newton step

Writes the Jacobian for the Newton iteration and passes it to the linear solver

Parameters

ntry	integer newton_try integer start number of Newton solver (1 or 2)
nnewt	integer number of current Newton step

Implements NewtonSolver.

Definition at line 180 of file newton_solver.cpp.

Here is the call graph for this function:

9.16 NewtonSolverIterative Class Reference

The NewtonSolverIterative provides access to the iterative linear solver for the Newton method.

```
#include <newton_solver.h>
```

Inheritance diagram for NewtonSolverIterative:

Collaboration diagram for NewtonSolverIterative:

Public Member Functions

- NewtonSolverIterative (realtype ∗t, AmiVector ∗x, Model ∗model, ReturnData ∗rdata)
- void solveLinearSystem (AmiVector ∗rhs)
- void prepareLinearSystem (int ntry, int nnewt)
- void linsolveSPBCG (int ntry, int nnewt, AmiVector ∗ns_delta)

Additional Inherited Members

9.16.1 Detailed Description

Definition at line 131 of file newton_solver.h.

9.16.2 Constructor & Destructor Documentation

9.16.2.1 NewtonSolverIterative()

```
NewtonSolverIterative (
            realtype * t,
            AmiVector * x,
            Model * model,
            ReturnData * rdata )
```

default constructor, initializes all members with the provided objects

Parameters

t	pointer to time variable
x	pointer to state variables
model	pointer to the AMICI model object
rdata	pointer to the return data object

Definition at line 324 of file newton_solver.cpp.

9.16.3 Member Function Documentation

9.16.3.1 solveLinearSystem()

```
void solveLinearSystem (
            AmiVector * rhs )  [virtual]
```

Solves the linear system for the Newton step

Parameters

rhs	containing the RHS of the linear system, will be overwritten by solution to the linear system

Solves the linear system for the Newton step by passing it to linsolveSPBCG

Parameters

rhs	containing the RHS of the linear system, will be overwritten by solution to the linear system

Implements NewtonSolver.

Definition at line 362 of file newton_solver.cpp.

Here is the call graph for this function:

9.16.3.2 prepareLinearSystem()

```
void prepareLinearSystem (
            int ntry,
            int nnewt )  [virtual]
```

Writes the Jacobian for the Newton iteration and passes it to the linear solver

Parameters

ntry	integer newton_try integer start number of Newton solver (1 or 2)
nnewt	integer number of current Newton step

Writes the Jacobian for the Newton iteration and passes it to the linear solver. Also wraps around getSensis for iterative linear solver.

Parameters

ntry	integer newton_try integer start number of Newton solver (1 or 2)
nnewt	integer number of current Newton step

Implements NewtonSolver.

Definition at line 341 of file newton_solver.cpp.

9.16.3.3 linsolveSPBCG()

```
void linsolveSPBCG (
            int ntry,
            int nnewt,
            AmiVector * ns_delta )
```

Iterative linear solver created from SPILS BiCG-Stab. Solves the linear system within each Newton step if iterative solver is chosen.

Parameters

ntry	integer newton_try integer start number of Newton solver (1 or 2)
nnewt	integer number of current Newton step
ns_delta	Newton step

Definition at line 375 of file newton_solver.cpp.

Here is the call graph for this function:

Here is the caller graph for this function:

9.17 NewtonSolverSparse Class Reference

The NewtonSolverSparse provides access to the sparse linear solver for the Newton method.

```
#include <newton_solver.h>
```

Inheritance diagram for NewtonSolverSparse:

Collaboration diagram for NewtonSolverSparse:

Public Member Functions

- NewtonSolverSparse (realtype ∗t, AmiVector ∗x, Model ∗model, ReturnData ∗rdata)
- void solveLinearSystem (AmiVector ∗rhs) override
- void prepareLinearSystem (int ntry, int nnewt) override

Additional Inherited Members

9.17.1 Detailed Description

Definition at line 105 of file newton_solver.h.

9.17.2 Constructor & Destructor Documentation

9.17.2.1 NewtonSolverSparse()

```
NewtonSolverSparse (
            realtype * t,
            AmiVector * x,
            Model * model,
            ReturnData * rdata )
```

default constructor, initializes all members with the provided objects, initializes temporary storage objects and the klu solver

Parameters

t	pointer to time variable
x	pointer to state variables
model	pointer to the AMICI model object
rdata	pointer to the return data object

Definition at line 230 of file newton_solver.cpp.

9.17.3 Member Function Documentation

9.17.3.1 solveLinearSystem()

```
void solveLinearSystem (
            AmiVector * rhs )  [override], [virtual]
```

Solves the linear system for the Newton step

Parameters

rhs	containing the RHS of the linear system, will be overwritten by solution to the linear system

Solves the linear system for the Newton step

Parameters

rhs	containing the RHS of the linear system,will be overwritten by solution to the linear system

Implements NewtonSolver.

Definition at line 290 of file newton_solver.cpp.

Here is the call graph for this function:

9.17.3.2 prepareLinearSystem()

```
void prepareLinearSystem (
            int ntry,
            int nnewt )  [override], [virtual]
```

Writes the Jacobian for the Newton iteration and passes it to the linear solver

Parameters

ntry	integer newton_try integer start number of Newton solver (1 or 2)
nnewt	integer number of current Newton step

Writes the Jacobian for the Newton iteration and passes it to the linear solver

Parameters

ntry	integer newton_try integer start number of Newton solver (1 or 2)
nnewt	integer number of current Newton step

Implements NewtonSolver.

Definition at line 250 of file newton_solver.cpp.

Here is the call graph for this function:

9.18 ReturnData Class Reference

class that stores all data which is later returned by the mex function

```
#include <rdata.h>
```

Collaboration diagram for ReturnData:

Public Member Functions

- ReturnData ()

  default constructor
- ReturnData (Solver const &solver, const Model *model)
- void initializeObjectiveFunction ()

  initializeObjectiveFunction
- void invalidate (const realtype t)
- void invalidateLLH ()
- void applyChainRuleFactorToSimulationResults (const Model *model)

Public Attributes

- std::vector< realtype > ts
- std::vector< realtype > xdot
- std::vector< realtype > J
- std::vector< realtype > z
- std::vector< realtype > sigmaz
- std::vector< realtype > sz
- std::vector< realtype > ssigmaz
- std::vector< realtype > rz
- std::vector< realtype > srz
- std::vector< realtype > s2rz
- std::vector< realtype > x
- std::vector< realtype > sx
- std::vector< realtype > y
- std::vector< realtype > sigmay
- std::vector< realtype > sy

- std::vector< realtype > ssigmay
- std::vector< realtype > res
- std::vector< realtype > sres
- std::vector< int > numsteps
- std::vector< int > numstepsB
- std::vector< int > numrhsevals
- std::vector< int > numrhsevalsB
- std::vector< int > numerrtestfails
- std::vector< int > numerrtestfailsB
- std::vector< int > numnonlinsolvconvfails
- std::vector< int > numnonlinsolvconvfailsB
- std::vector< int > order
- int newton_status = 0
- double newton_time = 0.0
- std::vector< int > newton_numsteps
- std::vector< int > newton_numlinsteps
- std::vector< realtype > x0
- std::vector< realtype > sx0
- realtype llh = 0.0
- realtype chi2 = 0.0
- std::vector< realtype > sllh
- std::vector< realtype > s2llh
- int status = 0
- const int np
- const int nk
- const int nx
- const int nxtrue
- const int ny
- const int nytrue
- const int nz
- const int nztrue
- const int ne
- const int nJ
- const int nplist
- const int nmaxevent
- const int nt
- const int newton_maxsteps
- std::vector< AMICI_parameter_scaling > pscale
- const AMICI_o2mode o2mode
- const AMICI_sensi_order sensi
- const AMICI_sensi_meth sensi_meth

Friends

- template<class Archive >
  void boost::serialization::serialize (Archive &ar, ReturnData &r, const unsigned int version)

  Serialize ReturnData (see boost::serialization::serialize)

9.18.1 Detailed Description

NOTE: multidimensional arrays are stored in row-major order (FORTRAN-style)

Definition at line 28 of file rdata.h.

9.18.2 Constructor & Destructor Documentation

9.18.2.1 ReturnData()

```
ReturnData (
            Solver const & solver,
            const Model * model )
```

constructor that uses information from model and solver to appropriately initialize fields

Parameters

solver	solver
model	pointer to model specification object bool

Definition at line 22 of file rdata.cpp.

Here is the call graph for this function:

9.18.3 Member Function Documentation

9.18.3.1 invalidate()

```
void invalidate (
            const realtype t )
```

routine to set likelihood, state variables, outputs and respective sensitivities to NaN (typically after integration failure)

Parameters

t	time of integration failure

Definition at line 100 of file rdata.cpp.

Here is the call graph for this function:

9.18.3.2 invalidateLLH()

```
void invalidateLLH ( )
```

routine to set likelihood and respective sensitivities to NaN (typically after integration failure)

Definition at line 139 of file rdata.cpp.

Here is the caller graph for this function:

9.18.3.3 applyChainRuleFactorToSimulationResults()

```
void applyChainRuleFactorToSimulationResults (
            const Model * model )
```

applies the chain rule to account for parameter transformation in the sensitivities of simulation results

Parameters

model	Model from which the ReturnData was obtained

Definition at line 151 of file rdata.cpp.

Here is the call graph for this function:

9.18.4 Friends And Related Function Documentation

9.18.4.1 boost::serialization::serialize

```
void boost::serialization::serialize (
            Archive & ar,
            ReturnData & r,
            const unsigned int version )  [friend]
```

Parameters

ar	Archive to serialize to
r	Data to serialize
version	Version number

9.18.5 Member Data Documentation

9.18.5.1 ts

```
std::vector<realtype> ts
```

timepoints (dimension: nt)

Definition at line 48 of file rdata.h.

9.18.5.2 xdot

```
std::vector<realtype> xdot
```

time derivative (dimension: nx)

Definition at line 51 of file rdata.h.

9.18.5.3 J

```
std::vector<realtype> J
```

Jacobian of differential equation right hand side (dimension: nx x nx, row-major)

Definition at line 55 of file rdata.h.

9.18.5.4 z

```
std::vector<realtype> z
```

event output (dimension: nmaxevent x nz, row-major)

Definition at line 58 of file rdata.h.

9.18.5.5 sigmaz

```
std::vector<realtype> sigmaz
```

event output sigma standard deviation (dimension: nmaxevent x nz, row-major)

Definition at line 62 of file rdata.h.

9.18.5.6 sz

```
std::vector<realtype> sz
```

parameter derivative of event output (dimension: nmaxevent x nz, row-major)

Definition at line 66 of file rdata.h.

9.18.5.7 ssigmaz

```
std::vector<realtype> ssigmaz
```

parameter derivative of event output standard deviation (dimension: nmaxevent x nz, row-major)

Definition at line 70 of file rdata.h.

9.18.5.8 rz

```
std::vector<realtype> rz
```

event trigger output (dimension: nmaxevent x nz, row-major)

Definition at line 73 of file rdata.h.

9.18.5.9 srz

```
std::vector<realtype> srz
```

parameter derivative of event trigger output (dimension: nmaxevent x nz x nplist, row-major)

Definition at line 77 of file rdata.h.

9.18.5.10 s2rz

```
std::vector<realtype> s2rz
```

second order parameter derivative of event trigger output (dimension: nmaxevent x nztrue x nplist x nplist, row-major)

Definition at line 81 of file rdata.h.

9.18.5.11 x

```
std::vector<realtype> x
```

state (dimension: nt x nx, row-major)

Definition at line 84 of file rdata.h.

9.18.5.12 sx

```
std::vector<realtype> sx
```

parameter derivative of state (dimension: nt x nx x nplist, row-major)

Definition at line 88 of file rdata.h.

9.18.5.13 y

```
std::vector<realtype> y
```

observable (dimension: nt x ny, row-major)

Definition at line 91 of file rdata.h.

9.18.5.14 sigmay

```
std::vector<realtype> sigmay
```

observable standard deviation (dimension: nt x ny, row-major)

Definition at line 94 of file rdata.h.

9.18.5.15 sy

```
std::vector<realtype> sy
```

parameter derivative of observable (dimension: nt x ny x nplist, row-major)

Definition at line 98 of file rdata.h.

9.18.5.16 ssigmay

```
std::vector<realtype> ssigmay
```

parameter derivative of observable standard deviation (dimension: nt x ny x nplist, row-major)

Definition at line 102 of file rdata.h.

9.18.5.17 res

```
std::vector<realtype> res
```

observable (dimension: nt x ny, row-major)

Definition at line 105 of file rdata.h.

9.18.5.18 sres

```
std::vector<realtype> sres
```

parameter derivative of residual (dimension: nt x ny x nplist, row-major)

Definition at line 109 of file rdata.h.

9.18.5.19 numsteps

```
std::vector<int> numsteps
```

number of integration steps forward problem (dimension: nt)

Definition at line 112 of file rdata.h.

9.18.5.20 numstepsB

```
std::vector<int> numstepsB
```

number of integration steps backward problem (dimension: nt)

Definition at line 115 of file rdata.h.

9.18.5.21 numrhsevals

```
std::vector<int> numrhsevals
```

number of right hand side evaluations forward problem (dimension: nt)

Definition at line 118 of file rdata.h.

9.18.5.22 numrhsevalsB

```
std::vector<int> numrhsevalsB
```

number of right hand side evaluations backwad problem (dimension: nt)

Definition at line 121 of file rdata.h.

9.18.5.23 numerrtestfails

```
std::vector<int> numerrtestfails
```

number of error test failures forward problem (dimension: nt)

Definition at line 124 of file rdata.h.

9.18.5.24 numerrtestfailsB

```
std::vector<int> numerrtestfailsB
```

number of error test failures backwad problem (dimension: nt)

Definition at line 127 of file rdata.h.

9.18.5.25 numnonlinsolvconvfails

```
std::vector<int> numnonlinsolvconvfails
```

number of linear solver convergence failures forward problem (dimension: nt)

Definition at line 131 of file rdata.h.

9.18.5.26 numnonlinsolvconvfailsB

```
std::vector<int> numnonlinsolvconvfailsB
```

number of linear solver convergence failures backwad problem (dimension: nt)

Definition at line 135 of file rdata.h.

9.18.5.27 order

```
std::vector<int> order
```

employed order forward problem (dimension: nt)

Definition at line 138 of file rdata.h.

9.18.5.28 newton_status

```
int newton_status = 0
```

flag indicating success of Newton solver

Definition at line 141 of file rdata.h.

9.18.5.29 newton_time

```
double newton_time = 0.0
```

computation time of the Newton solver [s]

Definition at line 144 of file rdata.h.

9.18.5.30 newton_numsteps

```
std::vector<int> newton_numsteps
```

number of Newton steps for steady state problem

Definition at line 147 of file rdata.h.

9.18.5.31 newton_numlinsteps

```
std::vector<int> newton_numlinsteps
```

number of linear steps by Newton step for steady state problem

Definition at line 150 of file rdata.h.

9.18.5.32 x0

```
std::vector<realtype> x0
```

preequilibration steady state found be Newton solver

Definition at line 153 of file rdata.h.

9.18.5.33 sx0

```
std::vector<realtype> sx0
```

preequilibration sensitivities found be Newton solver

Definition at line 156 of file rdata.h.

9.18.5.34 llh

```
realtype llh = 0.0
```

likelihood value (double[1])

Definition at line 159 of file rdata.h.

9.18.5.35 chi2

```
realtype chi2 = 0.0
```

chi2 value (double[1])

Definition at line 162 of file rdata.h.

9.18.5.36 sllh

```
std::vector<realtype> sllh
```

parameter derivative of likelihood (dimension: nplist)

Definition at line 165 of file rdata.h.

9.18.5.37 s2llh

```
std::vector<realtype> s2llh
```

second order parameter derivative of likelihood (dimension: (nJ-1) x nplist, row-major)

Definition at line 169 of file rdata.h.

9.18.5.38 status

```
int status = 0
```

status code (double[1])

Definition at line 172 of file rdata.h.

9.18.5.39 np

```
const int np
```

total number of model parameters

Definition at line 176 of file rdata.h.

9.18.5.40 nk

```
const int nk
```

number of fixed parameters

Definition at line 178 of file rdata.h.

9.18.5.41 nx

```
const int nx
```

number of states

Definition at line 180 of file rdata.h.

9.18.5.42 nxtrue

```
const int nxtrue
```

number of states in the unaugmented system

Definition at line 182 of file rdata.h.

9.18.5.43 ny

```
const int ny
```

number of observables

Definition at line 184 of file rdata.h.

9.18.5.44 nytrue

```
const int nytrue
```

number of observables in the unaugmented system

Definition at line 186 of file rdata.h.

9.18.5.45 nz

```
const int nz
```

number of event outputs

Definition at line 188 of file rdata.h.

9.18.5.46 nztrue

```
const int nztrue
```

number of event outputs in the unaugmented system

Definition at line 190 of file rdata.h.

9.18.5.47 ne

```
const int ne
```

number of events

Definition at line 192 of file rdata.h.

9.18.5.48 nJ

```
const int nJ
```

dimension of the augmented objective function for 2nd order ASA

Definition at line 194 of file rdata.h.

9.18.5.49 nplist

```
const int nplist
```

number of parameter for which sensitivities were requested

Definition at line 197 of file rdata.h.

9.18.5.50 nmaxevent

```
const int nmaxevent
```

maximal number of occuring events (for every event type)

Definition at line 199 of file rdata.h.

9.18.5.51 nt

```
const int nt
```

number of considered timepoints

Definition at line 201 of file rdata.h.

9.18.5.52 newton_maxsteps

```
const int newton_maxsteps
```

maximal number of newton iterations for steady state calculation

Definition at line 203 of file rdata.h.

9.18.5.53 pscale

```
std::vector<AMICI_parameter_scaling> pscale
```

scaling of parameterization (lin,log,log10)

Definition at line 205 of file rdata.h.

9.18.5.54 o2mode

```
const AMICI_o2mode o2mode
```

flag indicating whether second order sensitivities were requested

Definition at line 207 of file rdata.h.

9.18.5.55 sensi

```
const AMICI_sensi_order sensi
```

sensitivity order

Definition at line 209 of file rdata.h.

9.18.5.56 sensi_meth

```
const AMICI_sensi_meth sensi_meth
```

sensitivity method

Definition at line 211 of file rdata.h.

9.19 SetupFailure Class Reference

setup failure exception this exception should be thrown when the solver setup failed for this exception we can assume that we cannot recover from the exception and an error will be thrown

```
#include <exception.h>
```

Inheritance diagram for SetupFailure:

Collaboration diagram for SetupFailure:

Public Member Functions

- SetupFailure (const char *msg)

9.19.1 Detailed Description

Definition at line 166 of file exception.h.

9.19.2 Constructor & Destructor Documentation

9.19.2.1 SetupFailure()

```
SetupFailure (
            const char * msg )
```

constructor, simply calls AmiException constructor

Parameters

in	*msg*	

Definition at line 171 of file exception.h.

9.20 Solver Class Reference

```
#include <solver.h>
```

Public Member Functions

- Solver (const Solver &other)

  Solver copy constructor.
- virtual Solver ∗ clone () const =0

  Clone this instance.
- void setupAMI (ForwardProblem ∗fwd, Model ∗model)

  setupAMIs initialises the ami memory object
- void setupAMIB (BackwardProblem ∗bwd, Model ∗model)
- virtual void AMIGetSens (realtype ∗tret, AmiVectorArray ∗yySout)=0
- void getDiagnosis (const int it, ReturnData ∗rdata)
- void getDiagnosisB (const int it, ReturnData ∗rdata, const BackwardProblem ∗bwd)
- virtual void AMIGetRootInfo (int ∗rootsfound)=0
- virtual void AMIReInit (realtype t0, AmiVector ∗yy0, AmiVector ∗yp0)=0
- virtual void AMISensReInit (int ism, AmiVectorArray ∗yS0, AmiVectorArray ∗ypS0)=0
- virtual void AMICalcIC (realtype tout1, AmiVector ∗x, AmiVector ∗dx)=0
- virtual void AMICalcICB (int which, realtype tout1, AmiVector ∗xB, AmiVector ∗dxB)=0
- virtual int AMISolve (realtype tout, AmiVector ∗yret, AmiVector ∗ypret, realtype ∗tret, int itask)=0
- virtual int AMISolveF (realtype tout, AmiVector ∗yret, AmiVector ∗ypret, realtype ∗tret, int itask, int ∗ncheckPtr)=0
- virtual void AMISolveB (realtype tBout, int itaskB)=0
- virtual void AMISetStopTime (realtype tstop)=0
- virtual void AMIReInitB (int which, realtype tB0, AmiVector ∗yyB0, AmiVector ∗ypB0)=0

- virtual void AMIGetB (int which, realtype *tret, AmiVector *yy, AmiVector *yp)=0
- virtual void AMIGetQuadB (int which, realtype *tret, AmiVector *qB)=0
- virtual void AMIQuadReInitB (int which, AmiVector *yQB0)=0
- virtual void turnOffRootFinding ()=0
- AMICI_sensi_meth getSensitivityMethod () const
- void setSensitivityMethod (AMICI_sensi_meth sensi_meth)

  setSensitivityMethod
- int getNewtonMaxSteps () const

  getNewtonMaxSteps
- void setNewtonMaxSteps (int newton_maxsteps)

  setNewtonMaxSteps
- bool getNewtonPreequilibration () const

  getNewtonPreequilibration
- void setNewtonPreequilibration (bool newton_preeq)

  setNewtonPreequilibration
- int getNewtonPreconditioner () const

  getNewtonPreconditioner
- void setNewtonPreconditioner (int newton_precon)

  setNewtonPreconditioner
- int getNewtonMaxLinearSteps () const

  getNewtonMaxLinearSteps
- void setNewtonMaxLinearSteps (int newton_maxlinsteps)

  setNewtonMaxLinearSteps
- AMICI_sensi_order getSensitivityOrder () const

  getSensitivityOrder
- void setSensitivityOrder (AMICI_sensi_order sensi)

  setSensitivityOrder
- double getRelativeTolerance () const

  getRelativeTolerance
- void setRelativeTolerance (double rtol)

  setRelativeTolerance
- double getAbsoluteTolerance () const

  getAbsoluteTolerance
- void setAbsoluteTolerance (double atol)

  setAbsoluteTolerance
- double getRelativeToleranceQuadratures () const

  getRelativeToleranceQuadratures
- void setRelativeToleranceQuadratures (double rtol)

  setRelativeToleranceQuadratures
- double getAbsoluteToleranceQuadratures () const

  getAbsoluteToleranceQuadratures
- void setAbsoluteToleranceQuadratures (double atol)

  setAbsoluteToleranceQuadratures
- int getMaxSteps () const

  getMaxSteps
- void setMaxSteps (int maxsteps)

  setMaxSteps
- int getMaxStepsBackwardProblem () const

  getMaxStepsBackwardProblem
- void setMaxStepsBackwardProblem (int maxsteps)

  setMaxStepsBackwardProblem

- LinearMultistepMethod getLinearMultistepMethod () const

  getLinearMultistepMethod
- void setLinearMultistepMethod (LinearMultistepMethod lmm)

  setLinearMultistepMethod
- NonlinearSolverIteration getNonlinearSolverIteration () const

  getNonlinearSolverIteration
- void setNonlinearSolverIteration (NonlinearSolverIteration iter)

  setNonlinearSolverIteration
- InterpolationType getInterpolationType () const

  getInterpolationType
- void setInterpolationType (InterpolationType interpType)

  setInterpolationType
- StateOrdering getStateOrdering () const

  getStateOrdering
- void setStateOrdering (StateOrdering ordering)

  setStateOrdering
- int getStabilityLimitFlag () const

  getStabilityLimitFlag
- void setStabilityLimitFlag (int stldet)

  setStabilityLimitFlag
- LinearSolver getLinearSolver () const

  getLinearSolver
- void setLinearSolver (LinearSolver linsol)

  setLinearSolver
- InternalSensitivityMethod getInternalSensitivityMethod () const

  getInternalSensitivityMethod
- void setInternalSensitivityMethod (InternalSensitivityMethod ism)

  setInternalSensitivityMethod

Protected Member Functions

- virtual void init (AmiVector ∗x, AmiVector ∗dx, realtype t)=0
- virtual void binit (int which, AmiVector ∗xB, AmiVector ∗dxB, realtype t)=0
- virtual void qbinit (int which, AmiVector ∗qBdot)=0
- virtual void rootInit (int ne)=0
- virtual void sensInit1 (AmiVectorArray ∗sx, AmiVectorArray ∗sdx, int nplist)=0
- virtual void setDenseJacFn ()=0
- virtual void setSparseJacFn ()=0
- virtual void setBandJacFn ()=0
- virtual void setJacTimesVecFn ()=0
- virtual void setDenseJacFnB (int which)=0
- virtual void setSparseJacFnB (int which)=0
- virtual void setBandJacFnB (int which)=0
- virtual void setJacTimesVecFnB (int which)=0
- virtual void ∗ AMICreate (int lmm, int iter)=0
- virtual void AMISStolerances (double rtol, double atol)=0
- virtual void AMISensSStolerances (double rtol, double ∗atol)=0
- virtual void AMISetSensErrCon (bool error_corr)=0
- virtual void AMISetQuadErrConB (int which, bool flag)=0
- virtual void AMISetErrHandlerFn ()=0
- virtual void AMISetUserData (Model ∗model)=0

- virtual void AMISetUserDataB (int which, Model ∗model)=0
- virtual void AMISetMaxNumSteps (long int mxsteps)=0
- virtual void AMISetMaxNumStepsB (int which, long int mxstepsB)=0
- virtual void AMISetStabLimDet (int stldet)=0
- virtual void AMISetStabLimDetB (int which, int stldet)=0
- virtual void AMISetId (Model ∗model)=0
- virtual void AMISetSuppressAlg (bool flag)=0
- virtual void AMISetSensParams (realtype ∗p, realtype ∗pbar, int ∗plist)=0
- virtual void AMIGetDky (realtype t, int k, AmiVector ∗dky)=0
- virtual void AMIFree ()=0
- virtual void AMIAdjInit (long int steps, int interp)=0
- virtual void AMICreateB (int lmm, int iter, int ∗which)=0
- virtual void AMISStolerancesB (int which, realtype relTolB, realtype absTolB)=0
- virtual void AMIQuadSStolerancesB (int which, realtype reltolQB, realtype abstolQB)=0
- virtual void AMIDense (int nx)=0
- virtual void AMIDenseB (int which, int nx)=0
- virtual void AMIBand (int nx, int ubw, int lbw)=0
- virtual void AMIBandB (int which, int nx, int ubw, int lbw)=0
- virtual void AMIDiag ()=0
- virtual void AMIDiagB (int which)=0
- virtual void AMISpgmr (int prectype, int maxl)=0
- virtual void AMISpgmrB (int which, int prectype, int maxl)=0
- virtual void AMISpbcg (int prectype, int maxl)=0
- virtual void AMISpbcgB (int which, int prectype, int maxl)=0
- virtual void AMISptfqmr (int prectype, int maxl)=0
- virtual void AMISptfqmrB (int which, int prectype, int maxl)=0
- virtual void AMIKLU (int nx, int nnz, int sparsetype)=0
- virtual void AMIKLUSetOrdering (int ordering)=0
- virtual void AMIKLUSetOrderingB (int which, int ordering)=0
- virtual void AMIKLUB (int which, int nx, int nnz, int sparsetype)=0
- virtual void AMIGetNumSteps (void ∗ami_mem, long int ∗numsteps)=0
- virtual void AMIGetNumRhsEvals (void ∗ami_mem, long int ∗numrhsevals)=0
- virtual void AMIGetNumErrTestFails (void ∗ami_mem, long int ∗numerrtestfails)=0
- virtual void AMIGetNumNonlinSolvConvFails (void ∗ami_mem, long int ∗numnonlinsolvconvfails)=0
- virtual void AMIGetLastOrder (void ∗ami_mem, int ∗order)=0
- virtual void ∗ AMIGetAdjBmem (void ∗ami_mem, int which)=0
- void initializeLinearSolver (Model ∗model)
- void initializeLinearSolverB (Model ∗model, int which)

Static Protected Member Functions

- static void wrapErrHandlerFn (int error_code, const char ∗module, const char ∗function, char ∗msg, void ∗eh_data)

Protected Attributes

- void ∗ ami_mem = nullptr
- bool solverWasCalled = false

Friends

- template<class Archive >
  void boost::serialization::serialize (Archive &ar, Solver &r, const unsigned int version)

  Serialize Solver (see boost::serialization::serialize)
- bool operator== (const Solver &a, const Solver &b)

  Check equality of data members.

9.20.1 Detailed Description

Solver class. provides a generic interface to CVode and IDA solvers, individual realizations are realized in the CVodeSolver and the IDASolver class.

Definition at line 38 of file solver.h.

9.20.2 Constructor & Destructor Documentation

9.20.2.1 Solver()

```
Solver (
            const Solver & other )
```

Parameters

other	

Definition at line 46 of file solver.h.

9.20.3 Member Function Documentation

9.20.3.1 clone()

```
virtual Solver* clone ( ) const  [pure virtual]
```

Returns

The clone

9.20.3.2 setupAMI()

```
void setupAMI (
            ForwardProblem * fwd,
            Model * model )
```

Parameters

fwd	pointer to forward problem
model	pointer to the model object

Definition at line 23 of file solver.cpp.

Here is the call graph for this function:

Here is the caller graph for this function:

9.20.3.3 setupAMIB()

```
void setupAMIB (
            BackwardProblem * bwd,
            Model * model )
```

setupAMIB initialises the AMI memory object for the backwards problem

Parameters

bwd	pointer to backward problem
model	pointer to the model object

Definition at line 113 of file solver.cpp.

Here is the call graph for this function:

Here is the caller graph for this function:

9.20.3.4 AMIGetSens()

```
virtual void AMIGetSens (
            realtype * tret,
            AmiVectorArray * yySout )  [pure virtual]
```

AMIGetSens extracts diagnosis information from solver memory block and writes them into the return data instance

Parameters

tret	time at which the sensitivities should be computed
yySout	vector with sensitivities

9.20.3.5 getDiagnosis()

```
void getDiagnosis (
            const int it,
            ReturnData * rdata )
```

getDiagnosis extracts diagnosis information from solver memory block and writes them into the return data object

Parameters

it	time-point index
rdata	pointer to the return data object

Definition at line 215 of file solver.cpp.

Here is the call graph for this function:

9.20.3.6 getDiagnosisB()

```
void getDiagnosisB (
            const int it,
            ReturnData * rdata,
            const BackwardProblem * bwd )
```

getDiagnosisB extracts diagnosis information from solver memory block and writes them into the return data object for the backward problem

Parameters

it	time-point index
rdata	pointer to the return data object
bwd	pointer to backward problem

Definition at line 245 of file solver.cpp.

Here is the call graph for this function:

9.20.3.7 AMIGetRootInfo()

```
virtual void AMIGetRootInfo (
            int * rootsfound )  [pure virtual]
```

AMIGetRootInfo extracts information which event occured

Parameters

rootsfound	array with flags indicating whether the respective event occured

9.20.3.8 AMIReInit()

```
virtual void AMIReInit (
            realtype t0,
            AmiVector * yy0,
            AmiVector * yp0 )  [pure virtual]
```

AMIReInit reinitializes the states in the solver after an event occurence

Parameters

t0	new timepoint
yy0	new state variables
yp0	new derivative state variables (DAE only)

Here is the caller graph for this function:

9.20.3.9 AMISensReInit()

```
virtual void AMISensReInit (
            int ism,
            AmiVectorArray * yS0,
            AmiVectorArray * ypS0 )  [pure virtual]
```

AMISensReInit reinitializes the state sensitivites in the solver after an event occurence

Parameters

ism	sensitivity mode
yS0	new state sensitivity
ypS0	new derivative state sensitivities (DAE only)

Here is the caller graph for this function:

9.20.3.10 AMICalcIC()

```
virtual void AMICalcIC (
            realtype tout1,
            AmiVector * x,
            AmiVector * dx )  [pure virtual]
```

AMICalcIC calculates consistent initial conditions, assumes initial states to be correct (DAE only)

Parameters

tout1	next timepoint to be computed (sets timescale)
x	initial state variables
dx	initial derivative state variables (DAE only)

Here is the caller graph for this function:

9.20.3.11 AMICalcICB()

```
virtual void AMICalcICB (
            int which,
            realtype tout1,
            AmiVector * xB,
            AmiVector * dxB )  [pure virtual]
```

AMICalcIBC calculates consistent initial conditions for the backwards problem, assumes initial states to be correct (DAE only)

Parameters

which	identifier of the backwards problem
tout1	next timepoint to be computed (sets timescale)
xB	states of final solution of the forward problem
dxB	derivative states of final solution of the forward problem (DAE only)

Here is the caller graph for this function:

9.20.3.12 AMISolve()

```
virtual int AMISolve (
            realtype tout,
            AmiVector * yret,
            AmiVector * ypret,
            realtype * tret,
            int itask )  [pure virtual]
```

AMISolve solves the forward problem until a predefined timepoint

Parameters

tout	timepoint until which simulation should be performed
yret	states
ypret	derivative states (DAE only)
tret	pointer to the time variable
itask	task identifier, can be CV_NORMAL or CV_ONE_STEP

Returns

status flag indicating success of execution

Here is the caller graph for this function:

9.20.3.13 AMISolveF()

```
virtual int AMISolveF (
            realtype tout,
            AmiVector * yret,
            AmiVector * ypret,
            realtype * tret,
            int itask,
            int * ncheckPtr )  [pure virtual]
```

AMISolveF solves the forward problem until a predefined timepoint (adjoint only)

Parameters

tout	timepoint until which simulation should be performed
yret	states
ypret	derivative states (DAE only)
tret	pointer to the time variable
itask	task identifier, can be CV_NORMAL or CV_ONE_STEP
ncheckPtr	pointer to a number that counts the internal checkpoints

Returns

status flag indicating success of execution

Here is the caller graph for this function:

9.20.3.14 AMISolveB()

```
virtual void AMISolveB (
            realtype tBout,
            int itaskB )  [pure virtual]
```

AMISolveB solves the backward problem until a predefined timepoint (adjoint only)

Parameters

tBout	timepoint until which simulation should be performed
itaskB	task identifier, can be CV_NORMAL or CV_ONE_STEP

Here is the caller graph for this function:

9.20.3.15 AMISetStopTime()

```
virtual void AMISetStopTime (
            realtype tstop )  [pure virtual]
```

AMISetStopTime sets a timepoint at which the simulation will be stopped

Parameters

tstop	timepoint until which simulation should be performed

Here is the caller graph for this function:

9.20.3.16 AMIReInitB()

```
virtual void AMIReInitB (
            int which,
            realtype tB0,
            AmiVector * yyB0,
            AmiVector * ypB0 )  [pure virtual]
```

AMIReInitB reinitializes the adjoint states after an event occurence

Parameters

which	identifier of the backwards problem
tB0	new timepoint
yyB0	new adjoint state variables
ypB0	new adjoint derivative state variables (DAE only)

Here is the caller graph for this function:

9.20.3.17 AMIGetB()

```
virtual void AMIGetB (
            int which,
            realtype * tret,
            AmiVector * yy,
            AmiVector * yp )  [pure virtual]
```

AMIGetB returns the current adjoint states

Parameters

which	identifier of the backwards problem
tret	time at which the adjoint states should be computed
yy	adjoint state variables
yp	adjoint derivative state variables (DAE only)

Here is the caller graph for this function:

9.20.3.18 AMIGetQuadB()

```
virtual void AMIGetQuadB (
            int which,
            realtype * tret,
            AmiVector * qB )  [pure virtual]
```

AMIGetQuadB returns the current adjoint states

Parameters

which	identifier of the backwards problem
tret	time at which the adjoint states should be computed
qB	adjoint quadrature state variables

Here is the caller graph for this function:

9.20.3.19 AMIQuadReInitB()

```
virtual void AMIQuadReInitB (
            int which,
            AmiVector * yQB0 )  [pure virtual]
```

AMIReInitB reinitializes the adjoint states after an event occurence

Parameters

which	identifier of the backwards problem
yQB0	new adjoint quadrature state variables

Here is the caller graph for this function:

9.20.3.20 turnOffRootFinding()

```
virtual void turnOffRootFinding ( )  [pure virtual]
```

turnOffRootFinding disables rootfinding Here is the caller graph for this function:

9.20.3.21 getSensitivityMethod()

```
AMICI_sensi_meth getSensitivityMethod ( ) const
```

sensitivity method

Returns

method enum

Definition at line 244 of file solver.h.

9.20.3.22 setSensitivityMethod()

```
void setSensitivityMethod (
            AMICI_sensi_meth sensi_meth )
```

Parameters

sensi_meth	

Definition at line 252 of file solver.h.

9.20.3.23 getNewtonMaxSteps()

```
int getNewtonMaxSteps ( ) const
```

Returns

Definition at line 260 of file solver.h.

Here is the caller graph for this function:

9.20.3.24 setNewtonMaxSteps()

```
void setNewtonMaxSteps (
            int newton_maxsteps )
```

Parameters

newton_maxsteps	

Definition at line 268 of file solver.h.

9.20.3.25 getNewtonPreequilibration()

```
bool getNewtonPreequilibration ( ) const
```

Returns

Definition at line 276 of file solver.h.

Here is the caller graph for this function:

9.20.3.26 setNewtonPreequilibration()

```
void setNewtonPreequilibration (
            bool newton_preeq )
```

Parameters

newton_preeq	

Definition at line 284 of file solver.h.

9.20.3.27 getNewtonPreconditioner()

```
int getNewtonPreconditioner ( ) const
```

Returns

Definition at line 292 of file solver.h.

9.20.3.28 setNewtonPreconditioner()

```
void setNewtonPreconditioner (
            int newton_precon )
```

Parameters

newton_precon	

Definition at line 300 of file solver.h.

9.20.3.29 getNewtonMaxLinearSteps()

```
int getNewtonMaxLinearSteps ( ) const
```

Returns

Definition at line 310 of file solver.h.

Here is the caller graph for this function:

9.20.3.30 setNewtonMaxLinearSteps()

```
void setNewtonMaxLinearSteps (
            int newton_maxlinsteps )
```

Parameters

newton_maxlinsteps	

Definition at line 318 of file solver.h.

9.20.3.31 getSensitivityOrder()

```
AMICI_sensi_order getSensitivityOrder ( ) const
```

Returns

Definition at line 326 of file solver.h.

9.20.3.32 setSensitivityOrder()

```
void setSensitivityOrder (
            AMICI_sensi_order sensi )
```

Parameters

sensi	

Definition at line 334 of file solver.h.

9.20.3.33 getRelativeTolerance()

```
double getRelativeTolerance ( ) const
```

Returns

Definition at line 351 of file solver.h.

Here is the caller graph for this function:

9.20.3.34 setRelativeTolerance()

```
void setRelativeTolerance (
            double rtol )
```

Parameters

rtol	

Definition at line 359 of file solver.h.

9.20.3.35 getAbsoluteTolerance()

```
double getAbsoluteTolerance ( ) const
```

Returns

Definition at line 367 of file solver.h.

Here is the caller graph for this function:

9.20.3.36 setAbsoluteTolerance()

```
void setAbsoluteTolerance (
            double atol )
```

Parameters

atol	

Definition at line 375 of file solver.h.

9.20.3.37 getRelativeToleranceQuadratures()

```
double getRelativeToleranceQuadratures ( ) const
```

Returns

Definition at line 383 of file solver.h.

9.20.3.38 setRelativeToleranceQuadratures()

```
void setRelativeToleranceQuadratures (
            double rtol )
```

Parameters

rtol	

Definition at line 391 of file solver.h.

9.20.3.39 getAbsoluteToleranceQuadratures()

```
double getAbsoluteToleranceQuadratures ( ) const
```

Returns

Definition at line 399 of file solver.h.

9.20.3.40 setAbsoluteToleranceQuadratures()

```
void setAbsoluteToleranceQuadratures (
            double atol )
```

Parameters

atol	

Definition at line 407 of file solver.h.

9.20.3.41 getMaxSteps()

```
int getMaxSteps ( ) const
```

Returns

Definition at line 415 of file solver.h.

Here is the caller graph for this function:

9.20.3.42 setMaxSteps()

```
void setMaxSteps (
            int maxsteps )
```

Parameters

maxsteps	

Definition at line 423 of file solver.h.

9.20.3.43 getMaxStepsBackwardProblem()

```
int getMaxStepsBackwardProblem ( ) const
```

Returns

Definition at line 431 of file solver.h.

9.20.3.44 setMaxStepsBackwardProblem()

```
void setMaxStepsBackwardProblem (
            int maxsteps )
```

Parameters

maxsteps	

Definition at line 439 of file solver.h.

9.20.3.45 getLinearMultistepMethod()

```
LinearMultistepMethod getLinearMultistepMethod ( ) const
```

Returns

Definition at line 447 of file solver.h.

9.20.3.46 setLinearMultistepMethod()

```
void setLinearMultistepMethod (
            LinearMultistepMethod lmm )
```

Parameters

lmm	

Definition at line 455 of file solver.h.

9.20.3.47 getNonlinearSolverIteration()

```
NonlinearSolverIteration getNonlinearSolverIteration ( ) const
```

Returns

Definition at line 466 of file solver.h.

9.20.3.48 setNonlinearSolverIteration()

```
void setNonlinearSolverIteration (
            NonlinearSolverIteration iter )
```

Parameters

iter	

Definition at line 474 of file solver.h.

9.20.3.49 getInterpolationType()

```
InterpolationType getInterpolationType ( ) const
```

Returns

Definition at line 485 of file solver.h.

9.20.3.50 setInterpolationType()

```
void setInterpolationType (
            InterpolationType interpType )
```

Parameters

interpType	

Definition at line 493 of file solver.h.

9.20.3.51 getStateOrdering()

```
StateOrdering getStateOrdering ( ) const
```

Returns

Definition at line 501 of file solver.h.

Here is the caller graph for this function:

9.20.3.52 setStateOrdering()

```
void setStateOrdering (
            StateOrdering ordering )
```

Parameters

ordering	

Definition at line 509 of file solver.h.

9.20.3.53 getStabilityLimitFlag()

```
int getStabilityLimitFlag ( ) const
```

Returns

Definition at line 517 of file solver.h.

9.20.3.54 setStabilityLimitFlag()

```
void setStabilityLimitFlag (
            int stldet )
```

Parameters

stldet	

Definition at line 525 of file solver.h.

9.20.3.55 getLinearSolver()

```
LinearSolver getLinearSolver ( ) const
```

Returns

Definition at line 533 of file solver.h.

Here is the caller graph for this function:

9.20.3.56 setLinearSolver()

```
void setLinearSolver (
            LinearSolver linsol )
```

Parameters

linsol	

Definition at line 541 of file solver.h.

9.20.3.57 getInternalSensitivityMethod()

```
InternalSensitivityMethod getInternalSensitivityMethod ( ) const
```

Returns

Definition at line 549 of file solver.h.

Here is the caller graph for this function:

9.20.3.58 setInternalSensitivityMethod()

```
void setInternalSensitivityMethod (
            InternalSensitivityMethod ism )
```

Parameters

ism	

Definition at line 557 of file solver.h.

9.20.3.59 init()

```
virtual void init (
            AmiVector * x,
            AmiVector * dx,
            realtype t )  [protected], [pure virtual]
```

init initialises the states at the specified initial timepoint

Parameters

x	initial state variables
dx	initial derivative state variables (DAE only)
t	initial timepoint

Here is the caller graph for this function:

9.20.3.60 binit()

```
virtual void binit (
            int which,
            AmiVector * xB,
            AmiVector * dxB,
            realtype t )  [protected], [pure virtual]
```

binit initialises the adjoint states at the specified final timepoint

Parameters

which	identifier of the backwards problem
xB	initial adjoint state variables
dxB	initial adjoint derivative state variables (DAE only)
t	final timepoint

Here is the caller graph for this function:

9.20.3.61 qbinit()

```
virtual void qbinit (
            int which,
            AmiVector * qBdot )  [protected], [pure virtual]
```

qbinit initialises the quadrature states at the specified final timepoint

Parameters

which	identifier of the backwards problem
qBdot	initial adjoint quadrature state variables

Here is the caller graph for this function:

9.20.3.62 rootInit()

```
virtual void rootInit (
            int ne )  [protected], [pure virtual]
```

RootInit initialises the rootfinding for events

Parameters

ne	number of different events

Here is the caller graph for this function:

9.20.3.63 sensInit1()

```
virtual void sensInit1 (
            AmiVectorArray * sx,
            AmiVectorArray * sdx,
            int nplist )  [protected], [pure virtual]
```

SensInit1 initialises the sensitivities at the specified initial timepoint

Parameters

sx	initial state sensitivities
sdx	initial derivative state sensitivities (DAE only)
nplist	number parameter wrt which sensitivities are to be computed

Here is the caller graph for this function:

9.20.3.64 setDenseJacFn()

```
virtual void setDenseJacFn ( )  [protected], [pure virtual]
```

SetDenseJacFn sets the dense Jacobian function Here is the caller graph for this function:

9.20.3.65 setSparseJacFn()

```
virtual void setSparseJacFn ( ) [protected], [pure virtual]
```

SetSparseJacFn sets the sparse Jacobian function Here is the caller graph for this function:

9.20.3.66 setBandJacFn()

```
virtual void setBandJacFn ( ) [protected], [pure virtual]
```

SetBandJacFn sets the banded Jacobian function Here is the caller graph for this function:

9.20.3.67 setJacTimesVecFn()

```
virtual void setJacTimesVecFn ( ) [protected], [pure virtual]
```

SetJacTimesVecFn sets the Jacobian vector multiplication function Here is the caller graph for this function:

9.20.3.68 setDenseJacFnB()

```
virtual void setDenseJacFnB (
            int which )  [protected], [pure virtual]
```

SetDenseJacFn sets the dense Jacobian function

Parameters

which	identifier of the backwards problem

Here is the caller graph for this function:

9.20.3.69 setSparseJacFnB()

```
virtual void setSparseJacFnB (
            int which )  [protected], [pure virtual]
```

SetSparseJacFn sets the sparse Jacobian function

Parameters

which	identifier of the backwards problem

Here is the caller graph for this function:

9.20.3.70 setBandJacFnB()

```
virtual void setBandJacFnB (
            int which )  [protected], [pure virtual]
```

SetBandJacFn sets the banded Jacobian function

Parameters

which	identifier of the backwards problem

Here is the caller graph for this function:

9.20.3.71 setJacTimesVecFnB()

```
virtual void setJacTimesVecFnB (
            int which )  [protected], [pure virtual]
```

SetJacTimesVecFn sets the Jacobian vector multiplication function

Parameters

which	identifier of the backwards problem

Here is the caller graph for this function:

9.20.3.72 wrapErrHandlerFn()

```
void wrapErrHandlerFn (
            int error_code,
            const char * module,
            const char * function,
            char * msg,
            void * eh_data )  [static], [protected]
```

ErrHandlerFn extracts diagnosis information from solver memory block and writes them into the return data object for the backward problem

Parameters

error_code	error identifier
module	name of the module in which the error occured
function	name of the function in which the error occured **Type**: char
msg	error message
eh_data	unused input

Definition at line 173 of file solver.cpp.

9.20.3.73 AMICreate()

```
virtual void* AMICreate (
            int lmm,
            int iter )  [protected], [pure virtual]
```

AMICreate specifies solver method and initializes solver memory for the forward problem

Parameters

lmm	linear multistep method CV_ADAMS or CV_BDF
iter	nonlinear solver method CV_NEWTON or CV_FUNCTIONAL

Here is the caller graph for this function:

9.20.3.74 AMISStolerances()

```
virtual void AMISStolerances (
            double rtol,
            double atol )  [protected], [pure virtual]
```

AMISStolerances sets scalar relative and absolute tolerances for the forward problem

Parameters

rtol	relative tolerances
atol	absolute tolerances

Here is the caller graph for this function:

9.20.3.75 AMISensSStolerances()

```
virtual void AMISensSStolerances (
            double rtol,
            double * atol )  [protected], [pure virtual]
```

AMISensSStolerances activates sets scalar relative and absolute tolerances for the sensitivity variables

Parameters

rtol	relative tolerances
atol	array of absolute tolerances for every sensitivy variable

Here is the caller graph for this function:

9.20.3.76 AMISetSensErrCon()

```
virtual void AMISetSensErrCon (
            bool error_corr )  [protected], [pure virtual]
```

AMISetSensErrCon specifies whether error control is also enforced for sensitivities for the forward problem

Parameters

error_corr	activation flag

Here is the caller graph for this function:

9.20.3.77 AMISetQuadErrConB()

```
virtual void AMISetQuadErrConB (
            int which,
            bool flag )  [protected], [pure virtual]
```

AMISetSensErrCon specifies whether error control is also enforced for the backward quadrature problem

Parameters

which	identifier of the backwards problem
flag	activation flag

Here is the caller graph for this function:

9.20.3.78 AMISetErrHandlerFn()

```
virtual void AMISetErrHandlerFn ( )  [protected], [pure virtual]
```

AMISetErrHandlerFn attaches the error handler function (errMsgIdAndTxt) to the solver Here is the caller graph for this function:

9.20.3.79 AMISetUserData()

```
virtual void AMISetUserData (
            Model * model )  [protected], [pure virtual]
```

AMISetUserData attaches the user data instance (here this is a Model) to the forward problem

Parameters

model	Model instance,

Here is the caller graph for this function:

9.20.3.80 AMISetUserDataB()

```
virtual void AMISetUserDataB (
            int which,
            Model * model )  [protected], [pure virtual]
```

AMISetUserDataB attaches the user data instance (here this is a Model) to the backward problem

Parameters

which	identifier of the backwards problem
model	Model instance,

Here is the caller graph for this function:

9.20.3.81 AMISetMaxNumSteps()

```
virtual void AMISetMaxNumSteps (
            long int mxsteps )  [protected], [pure virtual]
```

AMISetMaxNumSteps specifies the maximum number of steps for the forward problem

Parameters

mxsteps	number of steps

Here is the caller graph for this function:

9.20.3.82 AMISetMaxNumStepsB()

```
virtual void AMISetMaxNumStepsB (
            int which,
            long int mxstepsB )  [protected], [pure virtual]
```

AMISetMaxNumStepsB specifies the maximum number of steps for the forward problem

Parameters

which	identifier of the backwards problem
mxstepsB	number of steps

Here is the caller graph for this function:

9.20.3.83 AMISetStabLimDet()

```
virtual void AMISetStabLimDet (
            int stldet )  [protected], [pure virtual]
```

AMISetStabLimDet activates stability limit detection for the forward problem

Parameters

stldet	flag for stability limit detection (TRUE or FALSE)

Here is the caller graph for this function:

9.20.3.84 AMISetStabLimDetB()

```
virtual void AMISetStabLimDetB (
            int which,
            int stldet )  [protected], [pure virtual]
```

AMISetStabLimDetB activates stability limit detection for the backward problem

Parameters

which	identifier of the backwards problem
stldet	flag for stability limit detection (TRUE or FALSE)

Here is the caller graph for this function:

9.20.3.85 AMISetId()

```
virtual void AMISetId (
            Model * model )  [protected], [pure virtual]
```

AMISetId specify algebraic/differential components (DAE only)

Parameters

model	model specification

Here is the caller graph for this function:

9.20.3.86 AMISetSuppressAlg()

```
virtual void AMISetSuppressAlg (
            bool flag )  [protected], [pure virtual]
```

AMISetId deactivates error control for algebraic components (DAE only)

Parameters

flag	deactivation flag

Here is the caller graph for this function:

9.20.3.87 AMISetSensParams()

```
virtual void AMISetSensParams (
            realtype * p,
            realtype * pbar,
            int * plist )  [protected], [pure virtual]
```

AMISetSensParams specifies the scaling and indexes for sensitivity computation

Parameters

p	paramaters
pbar	parameter scaling constants
plist	parameter index list

Here is the caller graph for this function:

9.20.3.88 AMIGetDky()

```
virtual void AMIGetDky (
            realtype t,
            int k,
            AmiVector * dky )  [protected], [pure virtual]
```

AMIGetDky interpolates the (derivative of the) solution at the requested timepoint

Parameters

t	timepoint
k	derivative order
dky	interpolated solution

9.20.3.89 AMIFree()

```
virtual void AMIFree ( )  [protected], [pure virtual]
```

AMIFree frees allocation solver memory Here is the caller graph for this function:

9.20.3.90 AMIAdjInit()

```
virtual void AMIAdjInit (
            long int steps,
            int interp )  [protected], [pure virtual]
```

AMIAdjInit initializes the adjoint problem

Parameters

steps	number of integration points between checkpoints
interp	interpolation type, can be CV_POLYNOMIAL or CV_HERMITE

Here is the caller graph for this function:

9.20.3.91 AMICreateB()

```
virtual void AMICreateB (
            int lmm,
            int iter,
            int * which )  [protected], [pure virtual]
```

AMICreateB specifies solver method and initializes solver memory for the backward problem

Parameters

which	identifier of the backwards problem
lmm	linear multistep method CV_ADAMS or CV_BDF
iter	nonlinear solver method CV_NEWTON or CV_FUNCTIONAL

Here is the caller graph for this function:

9.20.3.92 AMISStolerancesB()

```
virtual void AMISStolerancesB (
            int which,
            realtype relTolB,
            realtype absTolB )  [protected], [pure virtual]
```

AMISStolerancesB sets relative and absolute tolerances for the backward problem

Parameters

which	identifier of the backwards problem
relTolB	relative tolerances
absTolB	absolute tolerances

Here is the caller graph for this function:

9.20.3.93 AMIQuadSStolerancesB()

```
virtual void AMIQuadSStolerancesB (
            int which,
```

```
            realtype reltolQB,
            realtype abstolQB )  [protected], [pure virtual]
```

AMISStolerancesB sets relative and absolute tolerances for the quadrature backward problem

Parameters

which	identifier of the backwards problem
reltolQB	relative tolerances
abstolQB	absolute tolerances

Here is the caller graph for this function:

9.20.3.94 AMIDense()

```
virtual void AMIDense (
            int nx )  [protected], [pure virtual]
```

AMIDense attaches a dense linear solver to the forward problem

Parameters

nx	number of state variables

Here is the caller graph for this function:

9.20.3.95 AMIDenseB()

```
virtual void AMIDenseB (
            int which,
            int nx )  [protected], [pure virtual]
```

AMIDenseB attaches a dense linear solver to the backward problem

Parameters

which	identifier of the backwards problem
nx	number of state variables

Here is the caller graph for this function:

9.20.3.96 AMIBand()

```
virtual void AMIBand (
            int nx,
            int ubw,
            int lbw )  [protected], [pure virtual]
```

AMIBand attaches a banded linear solver to the forward problem

Parameters

nx	number of state variables
ubw	upper matrix bandwidth
lbw	lower matrix bandwidth

Here is the caller graph for this function:

9.20.3.97 AMIBandB()

```
virtual void AMIBandB (
            int which,
            int nx,
            int ubw,
            int lbw )  [protected], [pure virtual]
```

AMIBandB attaches a banded linear solver to the backward problem

Parameters

which	identifier of the backwards problem
nx	number of state variables
ubw	upper matrix bandwidth
lbw	lower matrix bandwidth

Here is the caller graph for this function:

9.20.3.98 AMIDiag()

```
virtual void AMIDiag ( )  [protected], [pure virtual]
```

AMIDiag attaches a diagonal linear solver to the forward problem Here is the caller graph for this function:

9.20.3.99 AMIDiagB()

```
virtual void AMIDiagB (
            int which )  [protected], [pure virtual]
```

AMIDiagB attaches a diagonal linear solver to the backward problem

Parameters

which	identifier of the backwards problem

Here is the caller graph for this function:

9.20.3.100 AMISpgmr()

```
virtual void AMISpgmr (
            int prectype,
            int maxl )  [protected], [pure virtual]
```

AMIDAMISpgmr attaches a scaled predonditioned GMRES linear solver to the forward problem

Parameters

prectype	preconditioner type PREC_NONE, PREC_LEFT, PREC_RIGHT or PREC_BOTH
maxl	maximum Kryloc subspace dimension

Here is the caller graph for this function:

9.20.3.101 AMISpgmrB()

```
virtual void AMISpgmrB (
            int which,
            int prectype,
            int maxl )  [protected], [pure virtual]
```

AMIDAMISpgmrB attaches a scaled predonditioned GMRES linear solver to the backward problem

Parameters

which	identifier of the backwards problem
prectype	preconditioner type PREC_NONE, PREC_LEFT, PREC_RIGHT or PREC_BOTH
maxl	maximum Kryloc subspace dimension

Here is the caller graph for this function:

9.20.3.102 AMISpbcg()

```
virtual void AMISpbcg (
            int prectype,
            int maxl )  [protected], [pure virtual]
```

AMISpbcg attaches a scaled predonditioned Bi-CGStab linear solver to the forward problem

Parameters

prectype	preconditioner type PREC_NONE, PREC_LEFT, PREC_RIGHT or PREC_BOTH
maxl	maximum Kryloc subspace dimension

Here is the caller graph for this function:

9.20.3.103 AMISpbcgB()

```
virtual void AMISpbcgB (
            int which,
            int prectype,
            int maxl )  [protected], [pure virtual]
```

AMISpbcgB attaches a scaled predonditioned Bi-CGStab linear solver to the backward problem

Parameters

which	identifier of the backwards problem
prectype	preconditioner type PREC_NONE, PREC_LEFT, PREC_RIGHT or PREC_BOTH
maxl	maximum Kryloc subspace dimension

Here is the caller graph for this function:

9.20.3.104 AMISptfqmr()

```
virtual void AMISptfqmr (
            int prectype,
            int maxl )  [protected], [pure virtual]
```

AMISptfqmr attaches a scaled predonditioned TFQMR linear solver to the forward problem

Parameters

prectype	preconditioner type PREC_NONE, PREC_LEFT, PREC_RIGHT or PREC_BOTH
maxl	maximum Kryloc subspace dimension

Here is the caller graph for this function:

9.20.3.105 AMISptfqmrB()

```
virtual void AMISptfqmrB (
            int which,
            int prectype,
            int maxl )  [protected], [pure virtual]
```

AMISptfqmrB attaches a scaled predonditioned TFQMR linear solver to the backward problem

Parameters

which	identifier of the backwards problem
prectype	preconditioner type PREC_NONE, PREC_LEFT, PREC_RIGHT or PREC_BOTH
maxl	maximum Kryloc subspace dimension

Here is the caller graph for this function:

9.20.3.106 AMIKLU()

```
virtual void AMIKLU (
            int nx,
            int nnz,
            int sparsetype )  [protected], [pure virtual]
```

AMIKLU attaches a sparse linear solver to the forward problem

Parameters

nx	number of state variables
nnz	number of nonzero entries in the jacobian
sparsetype	sparse storage type, CSC_MAT for column matrix, CSR_MAT for row matrix

Here is the caller graph for this function:

9.20.3.107 AMIKLUSetOrdering()

```
virtual void AMIKLUSetOrdering (
            int ordering )  [protected], [pure virtual]
```

AMIKLUSetOrdering sets the ordering for the sparse linear solver of the forward problem

Parameters

ordering	ordering algorithm to reduce fill 0:AMD 1:COLAMD 2: natural ordering

Here is the caller graph for this function:

9.20.3.108 AMIKLUSetOrderingB()

```
virtual void AMIKLUSetOrderingB (
            int which,
            int ordering )  [protected], [pure virtual]
```

AMIKLUSetOrderingB sets the ordering for the sparse linear solver of the backward problem

Parameters

which	identifier of the backwards problem
ordering	ordering algorithm to reduce fill 0:AMD 1:COLAMD 2: natural ordering

Here is the caller graph for this function:

9.20.3.109 AMIKLUB()

```
virtual void AMIKLUB (
            int which,
            int nx,
            int nnz,
            int sparsetype )  [protected], [pure virtual]
```

AMIKLUB attaches a sparse linear solver to the forward problem

Parameters

which	identifier of the backwards problem
nx	number of state variables
nnz	number of nonzero entries in the jacobian
sparsetype	sparse storage type, CSC_MAT for column matrix, CSR_MAT for row matrix

Here is the caller graph for this function:

9.20.3.110 AMIGetNumSteps()

```
virtual void AMIGetNumSteps (
            void * ami_mem,
            long int * numsteps )  [protected], [pure virtual]
```

AMIGetNumSteps reports the number of solver steps

Parameters

ami_mem	pointer to the solver memory instance (can be from forward or backward problem)
numsteps	output array

Here is the caller graph for this function:

9.20.3.111 AMIGetNumRhsEvals()

```
virtual void AMIGetNumRhsEvals (
            void * ami_mem,
            long int * numrhsevals )  [protected], [pure virtual]
```

AMIGetNumRhsEvals reports the number of right hand evaluations

Parameters

ami_mem	pointer to the solver memory instance (can be from forward or backward problem)
numrhsevals	output array

Here is the caller graph for this function:

9.20.3.112 AMIGetNumErrTestFails()

```
virtual void AMIGetNumErrTestFails (
            void * ami_mem,
            long int * numerrtestfails )  [protected], [pure virtual]
```

AMIGetNumErrTestFails reports the number of local error test failures

Parameters

ami_mem	pointer to the solver memory instance (can be from forward or backward problem)
numerrtestfails	output array

Here is the caller graph for this function:

9.20.3.113 AMIGetNumNonlinSolvConvFails()

```
virtual void AMIGetNumNonlinSolvConvFails (
            void * ami_mem,
            long int * numnonlinsolvconvfails )  [protected], [pure virtual]
```

AMIGetNumNonlinSolvConvFails reports the number of nonlinear convergence failures

Parameters

ami_mem	pointer to the solver memory instance (can be from forward or backward problem)
numnonlinsolvconvfails	output array

Here is the caller graph for this function:

9.20.3.114 AMIGetLastOrder()

```
virtual void AMIGetLastOrder (
            void * ami_mem,
            int * order )  [protected], [pure virtual]
```

AMIGetLastOrder reports the order of the integration method during the last internal step

Parameters

ami_mem	pointer to the solver memory instance (can be from forward or backward problem)
order	output array

Here is the caller graph for this function:

9.20.3.115 AMIGetAdjBmem()

```
virtual void* AMIGetAdjBmem (
            void * ami_mem,
            int which )  [protected], [pure virtual]
```

AMIGetAdjBmem retrieves the solver memory instance for the backward problem

Parameters

which	identifier of the backwards problem
ami_mem	pointer to the forward solver memory instance

Returns

ami_memB pointer to the backward solver memory instance

Here is the caller graph for this function:

9.20.3.116 initializeLinearSolver()

```
void initializeLinearSolver (
            Model * model )  [protected]
```

setLinearSolver sets the linear solver for the forward problem

Parameters

model	pointer to the model object

Definition at line 270 of file solver.cpp.

Here is the call graph for this function:

Here is the caller graph for this function:

9.20.3.117 initializeLinearSolverB()

```
void initializeLinearSolverB (
            Model * model,
            int which )  [protected]
```

Sets the linear solver for the backward problem

Parameters

model	pointer to the model object
which	index of the backward problem

Definition at line 347 of file solver.cpp.

Here is the call graph for this function:

Here is the caller graph for this function:

9.20.4 Friends And Related Function Documentation

9.20.4.1 boost::serialization::serialize

```
void boost::serialization::serialize (
            Archive & ar,
            Solver & r,
            const unsigned int version )  [friend]
```

Parameters

ar	Archive to serialize to
r	Data to serialize
version	Version number

9.20.4.2 operator==

```
bool operator== (
            const Solver & a,
            const Solver & b )  [friend]
```

Parameters

a	
b	

Returns

Definition at line 424 of file solver.cpp.

9.20.5 Member Data Documentation

9.20.5.1 ami_mem

```
void* ami_mem = nullptr  [protected]
```

pointer to ami memory block

Definition at line 1076 of file solver.h.

9.20.5.2 solverWasCalled

```
bool solverWasCalled = false  [protected]
```

flag indicating whether the solver was called

Definition at line 1079 of file solver.h.

9.21 SteadystateProblem Class Reference

The SteadystateProblem class solves a steady-state problem using Newton's method and falls back to integration on failure.

```
#include <steadystateproblem.h>
```

Public Member Functions

- void workSteadyStateProblem (ReturnData ∗rdata, Solver ∗solver, Model ∗model, int it)
- void applyNewtonsMethod (ReturnData ∗rdata, Model ∗model, NewtonSolver ∗newtonSolver, int newton_try)
- void getNewtonOutput (ReturnData ∗rdata, Model ∗model, int newton_status, double run_time, int it)
- void getNewtonSimulation (ReturnData ∗rdata, Solver ∗solver, Model ∗model, int it)
- SteadystateProblem (realtype ∗t, AmiVector ∗x, AmiVectorArray ∗sx)

9.21.1 Detailed Description

Definition at line 22 of file steadystateproblem.h.

9.21.2 Constructor & Destructor Documentation

9.21.2.1 SteadystateProblem()

```
SteadystateProblem (
            realtype * t,
            AmiVector * x,
            AmiVectorArray * sx )
```

default constructor

Parameters

t	pointer to time variable
x	pointer to state variables
sx	pointer to state sensitivity variables

Definition at line 47 of file steadystateproblem.h.

9.21.3 Member Function Documentation

9.21.3.1 workSteadyStateProblem()

```
void workSteadyStateProblem (
            ReturnData * rdata,
            Solver * solver,
            Model * model,
            int it )
```

Tries to determine the steady state of the ODE system by a Newton solver, uses forward intergration, if the Newton solver fails, restarts Newton solver, if integration fails. Computes steady state sensitivities

Parameters

in	*solver*	pointer to the AMICI solver object **Type**: Solver
in	*model*	pointer to the AMICI model object **Type**: Model
in	*it*	integer with the index of the current time step
out	*rdata*	pointer to the return data object **Type**: ReturnData

Definition at line 17 of file steadystateproblem.cpp.

Here is the call graph for this function:

Here is the caller graph for this function:

9.21.3.2 applyNewtonsMethod()

```
void applyNewtonsMethod (
            ReturnData * rdata,
            Model * model,
            NewtonSolver * newtonSolver,
            int newton_try )
```

applyNewtonsMethod applies Newtons method to the current state x to find the steady state Runs the Newton solver iterations and checks for convergence to steady state

Parameters

out	*rdata*	pointer to the return data object **Type**: ReturnData
in	*model*	pointer to the AMICI model object **Type**: Model
in	*newtonSolver*	pointer to the NewtonSolver object **Type**: NewtonSolver
in	*newton_try*	integer start number of Newton solver (1 or 2)

Definition at line 93 of file steadystateproblem.cpp.

Here is the call graph for this function:

Here is the caller graph for this function:

9.21.3.3 getNewtonOutput()

```
void getNewtonOutput (
            ReturnData * rdata,
            Model * model,
            int newton_status,
            double run_time,
            int it )
```

Stores output of workSteadyStateProblem in return data

Parameters

in	*model*	pointer to the AMICI model object **Type**: Model
in	*newton_status*	integer flag indicating when a steady state was found
in	*run_time*	double coputation time of the solver in milliseconds
out	*rdata*	pointer to the return data object **Type**: ReturnData
in	*it*	current timepoint index, <0 indicates preequilibration **Type**: int

Definition at line 196 of file steadystateproblem.cpp.

Here is the caller graph for this function:

9.21.3.4 getNewtonSimulation()

```
void getNewtonSimulation (
            ReturnData * rdata,
            Solver * solver,
            Model * model,
            int it )
```

Forward simulation is launched, if Newton solver fails in first try

Parameters

in	*solver*	pointer to the AMICI solver object **Type**: Solver
in	*model*	pointer to the AMICI model object **Type**: Model
out	*rdata*	pointer to the return data object **Type**: ReturnData
in	*it*	current timepoint index, <0 indicates preequilibration **Type**: int

Definition at line 234 of file steadystateproblem.cpp.

Here is the call graph for this function:

Here is the caller graph for this function:

9.22 amidata Class Reference

AMIDATA provides a data container to pass experimental data to the simulation routine for likelihood computation. when any of the properties are updated, the class automatically checks consistency of dimension and updates related properties and initialises them with NaNs.

Inheritance diagram for amidata:

Collaboration diagram for amidata:

Public Member Functions

- amidata (matlabtypesubstitute varargin)

  amidata creates an amidata container for experimental data with specified dimensions amidata.

Public Attributes

- matlabtypesubstitute nt = 0

  number of timepoints
- matlabtypesubstitute ny = 0

  number of observables
- matlabtypesubstitute nz = 0

  number of event observables
- matlabtypesubstitute ne = 0

  number of events
- matlabtypesubstitute nk = 0

  number of conditions/constants
- matlabtypesubstitute t = double.empty("")

  timepoints of observations

- matlabtypesubstitute Y = double.empty("")

  observations
- matlabtypesubstitute Sigma_Y = double.empty("")

  standard deviation of observations
- matlabtypesubstitute Z = double.empty("")

  event observations
- matlabtypesubstitute Sigma_Z = double.empty("")

  standard deviation of event observations
- matlabtypesubstitute condition = double.empty("")

  experimental condition
- matlabtypesubstitute conditionPreequilibration = double.empty("")

  experimental condition for preequilibration

9.22.1 Detailed Description

Definition at line 17 of file amidata.m.

9.22.2 Constructor & Destructor Documentation

9.22.2.1 amidata()

```
amidata (
            matlabtypesubstitute varargin )
```

AMIDATA(amidata) creates a copy of the input container

AMIDATA(struct) tries to creates an amidata container from the input struct. the struct should have the following

fields

t [nt,1] Y [nt,ny] Sigma_Y [nt,ny] Z [ne,nz] Sigma_Z [ne,nz] condition [nk,1] conditionPreequilibration [nk,1] if some fields are missing the function will try to initialise them with NaNs with consistent dimensions

AMIDATA(nt,ny,nz,ne,nk) constructs an empty data container with in the provided dimensions intialised with NaNs

Parameters

varargin	

Definition at line 130 of file amidata.m.

9.22.3 Member Data Documentation

9.22.3.1 nt

```
nt = 0
```

Default: 0

Note

This property has custom functionality when its value is changed.

Definition at line 31 of file amidata.m.

9.22.3.2 ny

```
ny = 0
```

Default: 0

Note

This property has custom functionality when its value is changed.

Definition at line 39 of file amidata.m.

9.22.3.3 nz

```
nz = 0
```

Default: 0

Note

This property has custom functionality when its value is changed.

Definition at line 47 of file amidata.m.

9.22.3.4 ne

```
ne = 0
```

Default: 0

Note

This property has custom functionality when its value is changed.

Definition at line 55 of file amidata.m.

9.22.3.5 nk

```
nk = 0
```

Default: 0

Note

This property has custom functionality when its value is changed.

Definition at line 63 of file amidata.m.

9.22.3.6 t

```
t = double.empty("")
```

Default: double.empty("")

Note

This property has custom functionality when its value is changed.

Definition at line 71 of file amidata.m.

9.22.3.7 Y

```
Y = double.empty("")
```

Default: double.empty("")

Note

This property has custom functionality when its value is changed.

Definition at line 79 of file amidata.m.

9.22.3.8 Sigma_Y

```
Sigma_Y = double.empty("")
```

Default: double.empty("")

Note

This property has custom functionality when its value is changed.

Definition at line 87 of file amidata.m.

9.22.3.9 Z

```
Z = double.empty("")
```

Default: double.empty("")

Note

This property has custom functionality when its value is changed.

Definition at line 95 of file amidata.m.

9.22.3.10 Sigma_Z

```
Sigma_Z = double.empty("")
```

Default: double.empty("")

Note

This property has custom functionality when its value is changed.

Definition at line 103 of file amidata.m.

9.22.3.11 condition

```
condition = double.empty("")
```

Default: double.empty("")

Note

This property has custom functionality when its value is changed.

Definition at line 111 of file amidata.m.

9.22.3.12 conditionPreequilibration

```
conditionPreequilibration = double.empty("")
```

Default: double.empty("")

Note

This property has custom functionality when its value is changed.

Definition at line 119 of file amidata.m.

9.23 amievent Class Reference

AMIEVENT defines events which later on will be transformed into appropriate C code.

Collaboration diagram for amievent:

Public Member Functions

- amievent (matlabtypesubstitute trigger, matlabtypesubstitute bolus, matlabtypesubstitute z)

  amievent constructs an amievent object from the provided input.
- mlhsInnerSubst< matlabtypesubstitute > setHflag (::double hflag)

  gethflag sets the hflag property.

Public Attributes

- ::symbolic trigger = sym.empty("")

  the trigger function activates the event on every zero crossing
- ::symbolic bolus = sym.empty("")

  the bolus function defines the change in states that is applied on every event occurence
- ::symbolic z = sym.empty("")

  output function for the event
- matlabtypesubstitute hflag = logical.empty("")

  flag indicating that a heaviside function is present, this helps to speed up symbolic computations

9.23.1 Detailed Description

Definition at line 17 of file amievent.m.

9.23.2 Constructor & Destructor Documentation

9.23.2.1 amievent()

```
amievent (
            matlabtypesubstitute trigger,
            matlabtypesubstitute bolus,
            matlabtypesubstitute z )
```

Parameters

trigger	trigger function, the event will be triggered on at all roots of this function
bolus	the bolus that will be added to all states on every occurence of the event
z	the event output that will be reported on every occurence of the event

Definition at line 75 of file amievent.m.

9.23.3 Member Function Documentation

9.23.3.1 setHflag()

```
mlhsInnerSubst<::amievent > setHflag (
            ::double hflag )
```

Parameters

hflag	value for the hflag property

Return values

this	updated event definition object

Definition at line 18 of file setHflag.m.

Here is the caller graph for this function:

9.23.4 Member Data Documentation

9.23.4.1 trigger

```
trigger = sym.empty("")
```

Note

This property has non-standard access specifiers: `SetAccess = Private, GetAccess = Public`
`Matlab documentation of property attributes.`
Default: sym.empty("")

Definition at line 27 of file amievent.m.

9.23.4.2 bolus

```
bolus = sym.empty("")
```

Note

This property has non-standard access specifiers: `SetAccess = Private, GetAccess = Public`
`Matlab documentation of property attributes.`
Default: sym.empty("")

Definition at line 38 of file amievent.m.

9.23.4.3 z

```
z = sym.empty("")
```

Note

This property has non-standard access specifiers: `SetAccess = Private, GetAccess = Public`
`Matlab documentation of property attributes.`
Default: sym.empty("")

Definition at line 49 of file amievent.m.

9.23.4.4 hflag

```
hflag = logical.empty("")
```

Note

This property has non-standard access specifiers: `SetAccess = Private, GetAccess = Public`
`Matlab documentation of property attributes.`
Default: logical.empty("")

Definition at line 60 of file amievent.m.

9.24 amifun Class Reference

AMIFUN defines functions which later on will be transformed into appropriate C code.

Collaboration diagram for amifun:

Public Member Functions

- amifun (matlabtypesubstitute funstr, matlabtypesubstitute model)

  amievent constructs an amifun object from the provided input.
- noret::substitute writeCcode_sensi (::amimodel model,::fileid fid)

  writeCcode_sensi is a wrapper for writeCcode which loops over parameters and reduces overhead by check nonzero values
- noret::substitute writeCcode (::amimodel model,::fileid fid)

  writeCcode is a wrapper for gccode which initialises data and reduces overhead by check nonzero values
- noret::substitute writeMcode (::amimodel model)

  writeMcode generates matlab evaluable code for specific model functions
- noret::substitute gccode (::amimodel model,::fileid fid)

  gccode transforms symbolic expressions into c code and writes the respective expression into a specified file
- mlhsInnerSubst< matlabtypesubstitute > getDeps (::amimodel model)

  getDeps populates the sensiflag for the requested function
- mlhsInnerSubst< matlabtypesubstitute > getArgs (::amimodel model)

  getFArgs populates the fargstr property with the argument string of the respective model function (if applicable). model functions are not wrapped versions of functions which have a model specific name and for which the call is solver specific.
- mlhsInnerSubst< matlabtypesubstitute > getNVecs ()

  getfunargs populates the nvecs property with the names of the N_Vector elements which are required in the execution of the function (if applicable). the information is directly extracted from the argument string
- mlhsInnerSubst< matlabtypesubstitute > getCVar ()

  getCVar populates the cvar property
- mlhsInnerSubst< matlabtypesubstitute > getSensiFlag ()

  getSensiFlag populates the sensiflag property
- mlhsSubst< mlhsInnerSubst< matlabtypesubstitute >,mlhsInnerSubst<::amimodel > > getSyms (::amimodel model)

  getSyms computes the symbolic expression for the requested function

Public Attributes

- ::symbolic sym = sym("[ ]")

  symbolic definition struct
- ::symbolic sym_noopt = sym("[ ]")

  symbolic definition which was not optimized (no dependencies on w)
- ::symbolic strsym = sym("[ ]")

  short symbolic string which can be used for the reuse of precomputed values
- ::symbolic strsym_old = sym("[ ]")

  short symbolic string which can be used for the reuse of old values
- ::char funstr = char.empty("")

  name of the model
- ::char cvar = char.empty("")

  name of the c variable
- ::char argstr = char.empty("")

  argument string (solver specific)
- ::cell deps = cell.empty("")

  dependencies on other functions
- matlabtypesubstitute nvecs = cell.empty("")

  nvec dependencies
- matlabtypesubstitute sensiflag = logical.empty("")

  indicates whether the function is a sensitivity or derivative with respect to parameters

9.24.1 Detailed Description

Definition at line 17 of file amifun.m.

9.24.2 Constructor & Destructor Documentation

9.24.2.1 amifun()

```
amifun (
            matlabtypesubstitute funstr,
            matlabtypesubstitute model )
```

Parameters

funstr	name of the requested function
model	amimodel object which carries all symbolic definitions to construct the function

Definition at line 111 of file amifun.m.

9.24.3 Member Function Documentation

9.24.3.1 writeCcode_sensi()

```
noret::substitute writeCcode_sensi (
            ::amimodel model,
            ::fileid fid )
```

Parameters

model	model defintion object
fid	file id in which the final expression is written

Return values

fid	void

Definition at line 18 of file writeCcode_sensi.m.

9.24.3.2 writeCcode()

```
noret::substitute writeCcode (
            ::amimodel model,
            ::fileid fid )
```

Parameters

model	model defintion object
fid	file id in which the final expression is written

Return values

fid	void

Definition at line 18 of file writeCcode.m.

Here is the call graph for this function:

9.24.3.3 writeMcode()

```
noret::substitute writeMcode (
            ::amimodel model )
```

Parameters

model	model defintion object

Return values

model	void

Definition at line 18 of file writeMcode.m.

Here is the call graph for this function:

9.24.3.4 gccode()

```
mlhsInnerSubst<::amifun > gccode (
            ::amimodel model,
            ::fileid fid )
```

Parameters

model	model definition object
fid	file id in which the expression should be written

Return values

this	function definition object

Definition at line 18 of file gccode.m.

Here is the caller graph for this function:

9.24.3.5 getDeps()

```
mlhsInnerSubst<::amifun > getDeps (
            ::amimodel model )
```

Parameters

model	model definition object

Return values

this	updated function definition object

Definition at line 18 of file getDeps.m.

9.24.3.6 getArgs()

```
mlhsInnerSubst<::amifun > getArgs (
            ::amimodel model )
```

Parameters

model	model definition object

Return values

this	updated function definition object

Definition at line 18 of file getArgs.m.

9.24.3.7 getNVecs()

```
mlhsInnerSubst<::amifun > getNVecs ( )
```

Return values

this	updated function definition object

Definition at line 18 of file getNVecs.m.

9.24.3.8 getCVar()

```
mlhsInnerSubst<::amifun > getCVar ( )
```

Return values

this	updated function definition object

Definition at line 18 of file getCVar.m.

9.24.3.9 getSensiFlag()

```
mlhsInnerSubst<::amifun > getSensiFlag ( )
```

Return values

this	updated function definition object

Definition at line 18 of file getSensiFlag.m.

9.24.3.10 getSyms()

```
mlhsSubst< mlhsInnerSubst<::amifun >,mlhsInnerSubst<::amimodel > > getSyms (
            ::amimodel model )
```

Parameters

model	model definition object

Return values

this	updated function definition object
model	updated model definition object

Definition at line 18 of file getSyms.m.

Here is the call graph for this function:

9.24.4 Member Data Documentation

9.24.4.1 sym

```
sym = sym("[]")
```

Default: sym("[]")

Definition at line 27 of file amifun.m.

9.24.4.2 sym_noopt

```
sym_noopt = sym("[]")
```

Default: sym("[]")

Definition at line 35 of file amifun.m.

9.24.4.3 strsym

```
strsym = sym("[]")
```

Default: sym("[]")

Definition at line 43 of file amifun.m.

9.24.4.4 strsym_old

```
strsym_old = sym("[]")
```

Default: sym("[]")

Definition at line 51 of file amifun.m.

9.24.4.5 funstr

```
funstr = char.empty("")
```

Default: char.empty("")

Definition at line 59 of file amifun.m.

9.24.4.6 cvar

```
cvar = char.empty("")
```

Default: char.empty("")

Definition at line 67 of file amifun.m.

9.24.4.7 argstr

```
argstr = char.empty("")
```

Default: char.empty("")

Definition at line 75 of file amifun.m.

9.24.4.8 deps

```
deps = cell.empty("")
```

Default: cell.empty("")

Definition at line 83 of file amifun.m.

9.24.4.9 nvecs

```
nvecs = cell.empty("")
```

Default: cell.empty("")

Definition at line 91 of file amifun.m.

9.24.4.10 sensiflag

```
sensiflag = logical.empty("")
```

Default: logical.empty("")

Definition at line 99 of file amifun.m.

9.25 amimodel Class Reference

AMIMODEL carries all model definitions including functions and events.

Inheritance diagram for amimodel:

Collaboration diagram for amimodel:

Public Member Functions

- amimodel (::string symfun,::string modelname)

  amimodel initializes the model object based on the provided symfun and modelname
- noret::substitute updateRHS (matlabtypesubstitute xdot)

  updateRHS updates the private fun property .fun.xdot.sym (right hand side of the differential equation)
- noret::substitute updateModelName (matlabtypesubstitute modelname)

  updateModelName updates the modelname
- noret::substitute updateWrapPath (matlabtypesubstitute wrap_path)

  updateModelName updates the modelname
- noret::substitute parseModel ()

  parseModel parses the model definition and computes all necessary symbolic expressions.
- noret::substitute generateC ()

  generateC generates the c files which will be used in the compilation.
- noret::substitute compileC ()

  compileC compiles the mex simulation file
- noret::substitute generateM (::amimodel amimodelo2)

  generateM generates the matlab wrapper for the compiled C files.
- noret::substitute getFun (::struct HTable,::string funstr)

  getFun generates symbolic expressions for the requested function.
- noret::substitute makeEvents ()

  makeEvents extracts discontiniuties from the model right hand side and converts them into events
- noret::substitute makeSyms ()

  makeSyms extracts symbolic definition from the user provided model and checks them for consistency
- mlhsInnerSubst< matlabtypesubstitute > checkDeps (::struct HTable,::cell deps)

  checkDeps checks the dependencies of functions and populates sym fields if necessary
- mlhsInnerSubst< matlabtypesubstitute > loadOldHashes ()

loadOldHashes loads information from a previous compilation of the model.

- mlhsInnerSubst< matlabtypesubstitute > augmento2 ()

  augmento2 augments the system equation to also include equations for sensitivity equation. This will enable us to compute second order sensitivities in a forward-adjoint or forward-forward apporach later on.

- mlhsInnerSubst< matlabtypesubstitute > augmento2vec ()

  augmento2 augments the system equation to also include equations for sensitivity equation. This will enable us to compute second order sensitivities in a forward-adjoint or forward-forward apporach later on.

Static Public Member Functions

- static noret::substitute compileAndLinkModel (matlabtypesubstitute modelname, matlabtypesubstitute modelSourceFolder, matlabtypesubstitute coptim, matlabtypesubstitute debug, matlabtypesubstitute funs, matlabtypesubstitute cfun)

  compileAndLinkModel compiles the mex simulation file. It does not check if the model files have changed since generating C++ code or whether all files are still present. Use only if you know what you are doing. The safer alternative is rerunning amiwrap().

- static noret::substitute generateMatlabWrapper (matlabtypesubstitute nx, matlabtypesubstitute ny, matlabtypesubstitute np, matlabtypesubstitute nk, matlabtypesubstitute nz, matlabtypesubstitute o2flag,::amimodel amimodelo2, matlabtypesubstitute wrapperFilename, matlabtypesubstitute modelname, matlabtypesubstitute pscale, matlabtypesubstitute forward, matlabtypesubstitute adjoint)

  generateMatlabWrapper generates the matlab wrapper for the compiled C files.

Public Attributes

- ::struct sym = struct.empty("")

  symbolic definition struct

- ::struct fun = struct.empty("")

  struct which stores information for which functions c code needs to be generated

- ::amievent event = amievent.empty("")

  struct which stores information for which functions c code needs to be generated

- ::string modelname = char.empty("")

  name of the model

- ::struct HTable = struct.empty("")

  struct that contains hash values for the symbolic model definitions

- ::bool debug = false

  flag indicating whether debugging symbols should be compiled

- ::bool adjoint = true

  flag indicating whether adjoint sensitivities should be enabled

- ::bool forward = true

  flag indicating whether forward sensitivities should be enabled

- ::double t0 = 0

  default initial time

- ::string wtype = char.empty("")

  type of wrapper (cvodes/idas)

- ::int nx = double.empty("")

  number of states

- ::int nxtrue = double.empty("")

  number of original states for second order sensitivities

- ::int ny = double.empty("")

  number of observables

- ::int nytrue = double.empty("")

number of original observables for second order sensitivities

- ::int np = double.empty("")

  number of parameters
- ::int nk = double.empty("")

  number of constants
- ::int ng = double.empty("")

  number of objective functions
- ::int nevent = double.empty("")

  number of events
- ::int nz = double.empty("")

  number of event outputs
- ::int nztrue = double.empty("")

  number of original event outputs for second order sensitivities
- ::∗int id = double.empty("")

  flag for DAEs
- ::int ubw = double.empty("")

  upper Jacobian bandwidth
- ::int lbw = double.empty("")

  lower Jacobian bandwidth
- ::int nnz = double.empty("")

  number of nonzero entries in Jacobian
- ::∗int sparseidx = double.empty("")

  dataindexes of sparse Jacobian
- ::∗int rowvals = double.empty("")

  rowindexes of sparse Jacobian
- ::∗int colptrs = double.empty("")

  columnindexes of sparse Jacobian
- ::∗int sparseidxB = double.empty("")

  dataindexes of sparse Jacobian
- ::∗int rowvalsB = double.empty("")

  rowindexes of sparse Jacobian
- ::∗int colptrsB = double.empty("")

  columnindexes of sparse Jacobian
- ::∗cell funs = cell.empty("")

  cell array of functions to be compiled
- ::∗cell mfuns = cell.empty("")

  cell array of matlab functions to be compiled
- ::string coptim = "-O3"

  optimisation flag for compilation
- ::string param = "lin"

  default parametrisation
- matlabtypesubstitute wrap_path = char.empty("")

  path to wrapper
- matlabtypesubstitute recompile = false

  flag to enforce recompilation of the model
- matlabtypesubstitute cfun = struct.empty("")

  storage for flags determining recompilation of individual functions
- matlabtypesubstitute o2flag = 0

  flag which identifies augmented models 0 indicates no augmentation 1 indicates augmentation by first order sensitivities (yields second order sensitivities) 2 indicates augmentation by one linear combination of first order sensitivities (yields hessian-vector product)

- matlabtypesubstitute z2event = double.empty("")

  vector that maps outputs to events
- matlabtypesubstitute splineflag = false

  flag indicating whether the model contains spline functions
- matlabtypesubstitute minflag = false

  flag indicating whether the model contains min functions
- matlabtypesubstitute maxflag = false

  flag indicating whether the model contains max functions
- ::int nw = 0

  number of derived variables w, w is used for code optimization to reduce the number of frequently occuring expressions
- ::int ndwdx = 0

  number of derivatives of derived variables w, dwdx
- ::int ndwdp = 0

  number of derivatives of derived variables w, dwdp

9.25.1 Detailed Description

Definition at line 17 of file amimodel.m.

9.25.2 Constructor & Destructor Documentation

9.25.2.1 amimodel()

```
amimodel (
            ::string symfun,
            ::string modelname )
```

Parameters

symfun	this is the string to the function which generates the modelstruct. You can also directly pass the struct here
modelname	name of the model

Definition at line 515 of file amimodel.m.

Here is the caller graph for this function:

9.25.3 Member Function Documentation

9.25.3.1 updateRHS()

```
noret::substitute updateRHS (
            matlabtypesubstitute xdot )
```

Parameters

xdot	new right hand side of the differential equation

Return values

xdot	void

Definition at line 612 of file amimodel.m.

Here is the caller graph for this function:

9.25.3.2 updateModelName()

```
noret::substitute updateModelName (
            matlabtypesubstitute modelname )
```

Parameters

modelname	new modelname

Return values

modelname	void

Definition at line 627 of file amimodel.m.

9.25.3.3 updateWrapPath()

```
noret::substitute updateWrapPath (
            matlabtypesubstitute wrap_path )
```

Parameters

wrap_path	new wrap_path

Return values

wrap_path	void

Definition at line 640 of file amimodel.m.

9.25.3.4 parseModel()

```
noret::substitute parseModel ( )
```

Return values

void	

Definition at line 18 of file parseModel.m.

Here is the call graph for this function:

9.25.3.5 generateC()

```
noret::substitute generateC ( )
```

Return values

void	

Definition at line 18 of file generateC.m.

9.25.3.6 compileC()

```
noret::substitute compileC ( )
```

Return values

void	

Definition at line 18 of file compileC.m.

Here is the call graph for this function:

9.25.3.7 generateM()

```
noret::substitute generateM (
            ::amimodel amimodelo2 )
```

Parameters

amimodelo2	this struct must contain all necessary symbolic definitions for second order sensivities

Return values

amimodelo2	void

Definition at line 18 of file generateM.m.

Here is the call graph for this function:

9.25.3.8 getFun()

```
noret::substitute getFun (
            ::struct HTable,
            ::string funstr )
```

Parameters

HTable	struct with hashes of symbolic definition from the previous compilation
funstr	function for which symbolic expressions should be computed

Return values

funstr	void

Definition at line 18 of file getFun.m.

Here is the call graph for this function:

Here is the caller graph for this function:

9.25.3.9 makeEvents()

```
noret::substitute makeEvents ( )
```

Return values

void	

Definition at line 18 of file makeEvents.m.

Here is the call graph for this function:

9.25.3.10 makeSyms()

```
noret::substitute makeSyms ( )
```

Return values

void	

Definition at line 18 of file makeSyms.m.

9.25.3.11 checkDeps()

```
mlhsInnerSubst<::bool > checkDeps (
            ::struct HTable,
            ::cell deps )
```

Parameters

HTable	struct with reference hashes of functions in its fields
deps	cell array with containing a list of dependencies

Return values

cflag	boolean indicating whether any of the dependencies have changed with respect to the hashes stored in HTable

Definition at line 18 of file checkDeps.m.

Here is the call graph for this function:

Here is the caller graph for this function:

9.25.3.12 loadOldHashes()

```
mlhsInnerSubst<::struct > loadOldHashes ( )
```

Return values

HTable	struct with hashes of symbolic definition from the previous compilation

Definition at line 18 of file loadOldHashes.m.

Here is the caller graph for this function:

9.25.3.13 augmento2()

```
mlhsInnerSubst< matlabtypesubstitute > augmento2 ( )
```

Return values

this	augmented system which contains symbolic definition of the original system and its sensitivities

Definition at line 18 of file augmento2.m.

Here is the call graph for this function:

9.25.3.14 augmento2vec()

```
mlhsInnerSubst<::amimodel > augmento2vec ( )
```

Return values

modelo2vec	augmented system which contains symbolic definition of the original system and its sensitivities

Definition at line 18 of file augmento2vec.m.

Here is the call graph for this function:

9.25.3.15 compileAndLinkModel()

```
noret::substitute compileAndLinkModel (
            matlabtypesubstitute modelname,
            matlabtypesubstitute modelSourceFolder,
            matlabtypesubstitute coptim,
            matlabtypesubstitute debug,
            matlabtypesubstitute funs,
            matlabtypesubstitute cfun )  [static]
```

Parameters

modelname	name of the model as specified for amiwrap()
modelSourceFolder	path to model source directory
coptim	optimization flags
debug	enable debugging
funs	array with names of the model functions, will be guessed from source files if left empty
cfun	struct indicating which files should be recompiled

Return values

cfun	void

Definition at line 18 of file compileAndLinkModel.m.

Here is the caller graph for this function:

9.25.3.16 generateMatlabWrapper()

```
noret::substitute generateMatlabWrapper (
            matlabtypesubstitute nx,
            matlabtypesubstitute ny,
            matlabtypesubstitute np,
            matlabtypesubstitute nk,
            matlabtypesubstitute nz,
            matlabtypesubstitute o2flag,
            ::amimodel amimodelo2,
            matlabtypesubstitute wrapperFilename,
            matlabtypesubstitute modelname,
            matlabtypesubstitute pscale,
            matlabtypesubstitute forward,
            matlabtypesubstitute adjoint )  [static]
```

Parameters

nx	number of states
ny	number of observables
np	number of parameters
nk	number of fixed parameters
nz	number of events
o2flag	o2flag
amimodelo2	this struct must contain all necessary symbolic definitions for second order sensivities
wrapperFilename	output filename
modelname	name of the model
pscale	default parameter scaling
forward	has forward sensitivity equations
adjoint	has adjoint sensitivity equations

Return values

adjoint	void

Definition at line 18 of file generateMatlabWrapper.m.

Here is the caller graph for this function:

9.25.4 Member Data Documentation

9.25.4.1 sym

```
sym = struct.empty("")
```

Note

This property has non-standard access specifiers: `SetAccess = Private, GetAccess = Public`
Matlab documentation of property attributes.
Default: struct.empty("")

Definition at line 27 of file amimodel.m.

9.25.4.2 fun

```
fun = struct.empty("")
```

Note

This property has non-standard access specifiers: `SetAccess = Private, GetAccess = Public`
Matlab documentation of property attributes.
Default: struct.empty("")

Definition at line 38 of file amimodel.m.

9.25.4.3 event

```
event = amievent.empty("")
```

Note

This property has non-standard access specifiers: `SetAccess = Private, GetAccess = Public`
Matlab documentation of property attributes.
Default: amievent.empty("")

Definition at line 49 of file amimodel.m.

9.25.4.4 modelname

```
modelname = char.empty("")
```

Note

This property has non-standard access specifiers: `SetAccess = Private, GetAccess = Public`
Matlab documentation of property attributes.
Default: char.empty("")

Definition at line 61 of file amimodel.m.

9.25.4.5 HTable

```
HTable = struct.empty("")
```

Note

This property has non-standard access specifiers: `SetAccess = Private, GetAccess = Public`
`Matlab documentation of property attributes.`
Default: struct.empty("")

Definition at line 72 of file amimodel.m.

9.25.4.6 debug

```
debug = false
```

Note

This property has non-standard access specifiers: `SetAccess = Private, GetAccess = Public`
`Matlab documentation of property attributes.`
Default: false

Definition at line 83 of file amimodel.m.

9.25.4.7 adjoint

```
adjoint = true
```

Note

This property has non-standard access specifiers: `SetAccess = Private, GetAccess = Public`
`Matlab documentation of property attributes.`
Default: true

Definition at line 94 of file amimodel.m.

9.25.4.8 forward

```
forward = true
```

Note

This property has non-standard access specifiers: `SetAccess = Private, GetAccess = Public`
`Matlab documentation of property attributes.`
Default: true

Definition at line 105 of file amimodel.m.

9.25.4.9 t0

```
t0 = 0
```

Note

This property has non-standard access specifiers: `SetAccess = Private, GetAccess = Public`
`Matlab documentation of property attributes.`
Default: 0

Definition at line 116 of file amimodel.m.

9.25.4.10 wtype

```
wtype = char.empty("")
```

Note

This property has non-standard access specifiers: `SetAccess = Private, GetAccess = Public`
`Matlab documentation of property attributes.`
Default: char.empty("")

Definition at line 127 of file amimodel.m.

9.25.4.11 nx

```
nx = double.empty("")
```

Note

This property has non-standard access specifiers: `SetAccess = Private, GetAccess = Public`
`Matlab documentation of property attributes.`
Default: double.empty("")

Definition at line 138 of file amimodel.m.

9.25.4.12 nxtrue

```
nxtrue = double.empty("")
```

Note

This property has non-standard access specifiers: `SetAccess = Private, GetAccess = Public`
`Matlab documentation of property attributes.`
Default: double.empty("")

Definition at line 149 of file amimodel.m.

9.25.4.13 ny

```
ny = double.empty("")
```

Note

This property has non-standard access specifiers: `SetAccess = Private, GetAccess = Public`
`Matlab documentation of property attributes.`
Default: double.empty("")

Definition at line 160 of file amimodel.m.

9.25.4.14 nytrue

```
nytrue = double.empty("")
```

Note

This property has non-standard access specifiers: `SetAccess = Private, GetAccess = Public`
`Matlab documentation of property attributes.`
Default: double.empty("")

Definition at line 171 of file amimodel.m.

9.25.4.15 np

```
np = double.empty("")
```

Note

This property has non-standard access specifiers: `SetAccess = Private, GetAccess = Public`
`Matlab documentation of property attributes.`
Default: double.empty("")

Definition at line 182 of file amimodel.m.

9.25.4.16 nk

```
nk = double.empty("")
```

Note

This property has non-standard access specifiers: `SetAccess = Private, GetAccess = Public`
`Matlab documentation of property attributes.`
Default: double.empty("")

Definition at line 193 of file amimodel.m.

9.25.4.17 ng

```
ng = double.empty("")
```

Note

This property has non-standard access specifiers: `SetAccess = Private, GetAccess = Public`
Matlab documentation of property attributes.
Default: double.empty("")

Definition at line 204 of file amimodel.m.

9.25.4.18 nevent

```
nevent = double.empty("")
```

Note

This property has non-standard access specifiers: `SetAccess = Private, GetAccess = Public`
Matlab documentation of property attributes.
Default: double.empty("")

Definition at line 215 of file amimodel.m.

9.25.4.19 nz

```
nz = double.empty("")
```

Note

This property has non-standard access specifiers: `SetAccess = Private, GetAccess = Public`
Matlab documentation of property attributes.
Default: double.empty("")

Definition at line 226 of file amimodel.m.

9.25.4.20 nztrue

```
nztrue = double.empty("")
```

Note

This property has non-standard access specifiers: `SetAccess = Private, GetAccess = Public`
Matlab documentation of property attributes.
Default: double.empty("")

Definition at line 237 of file amimodel.m.

9.25.4.21 id

```
id = double.empty("")
```

Note

This property has non-standard access specifiers: `SetAccess = Private, GetAccess = Public`
`Matlab documentation of property attributes.`
Default: double.empty("")

Definition at line 248 of file amimodel.m.

9.25.4.22 ubw

```
ubw = double.empty("")
```

Note

This property has non-standard access specifiers: `SetAccess = Private, GetAccess = Public`
`Matlab documentation of property attributes.`
Default: double.empty("")

Definition at line 259 of file amimodel.m.

9.25.4.23 lbw

```
lbw = double.empty("")
```

Note

This property has non-standard access specifiers: `SetAccess = Private, GetAccess = Public`
`Matlab documentation of property attributes.`
Default: double.empty("")

Definition at line 270 of file amimodel.m.

9.25.4.24 nnz

```
nnz = double.empty("")
```

Note

This property has non-standard access specifiers: `SetAccess = Private, GetAccess = Public`
`Matlab documentation of property attributes.`
Default: double.empty("")

Definition at line 281 of file amimodel.m.

9.25.4.25 sparseidx

```
sparseidx = double.empty("")
```

Note

This property has non-standard access specifiers: `SetAccess = Private, GetAccess = Public`
Matlab documentation of property attributes.
Default: double.empty("")

Definition at line 292 of file amimodel.m.

9.25.4.26 rowvals

```
rowvals = double.empty("")
```

Note

This property has non-standard access specifiers: `SetAccess = Private, GetAccess = Public`
Matlab documentation of property attributes.
Default: double.empty("")

Definition at line 303 of file amimodel.m.

9.25.4.27 colptrs

```
colptrs = double.empty("")
```

Note

This property has non-standard access specifiers: `SetAccess = Private, GetAccess = Public`
Matlab documentation of property attributes.
Default: double.empty("")

Definition at line 314 of file amimodel.m.

9.25.4.28 sparseidxB

```
sparseidxB = double.empty("")
```

Note

This property has non-standard access specifiers: `SetAccess = Private, GetAccess = Public`
Matlab documentation of property attributes.
Default: double.empty("")

Definition at line 325 of file amimodel.m.

9.25.4.29 rowvalsB

```
rowvalsB = double.empty("")
```

Note

This property has non-standard access specifiers: `SetAccess = Private, GetAccess = Public`
Matlab documentation of property attributes.
Default: double.empty("")

Definition at line 336 of file amimodel.m.

9.25.4.30 colptrsB

```
colptrsB = double.empty("")
```

Note

This property has non-standard access specifiers: `SetAccess = Private, GetAccess = Public`
Matlab documentation of property attributes.
Default: double.empty("")

Definition at line 347 of file amimodel.m.

9.25.4.31 funs

```
funs = cell.empty("")
```

Note

This property has non-standard access specifiers: `SetAccess = Private, GetAccess = Public`
Matlab documentation of property attributes.
Default: cell.empty("")

Definition at line 358 of file amimodel.m.

9.25.4.32 mfuns

```
mfuns = cell.empty("")
```

Note

This property has non-standard access specifiers: `SetAccess = Private, GetAccess = Public`
Matlab documentation of property attributes.
Default: cell.empty("")

Definition at line 369 of file amimodel.m.

9.25.4.33 coptim

```
coptim = "-O3"
```

Note

This property has non-standard access specifiers: `SetAccess = Private, GetAccess = Public`
Matlab documentation of property attributes.
Default: "-O3"

Definition at line 380 of file amimodel.m.

9.25.4.34 param

```
param = "lin"
```

Note

This property has non-standard access specifiers: `SetAccess = Private, GetAccess = Public`
Matlab documentation of property attributes.
Default: "lin"

Definition at line 391 of file amimodel.m.

9.25.4.35 wrap_path

```
wrap_path = char.empty("")
```

Note

This property has non-standard access specifiers: `SetAccess = Private, GetAccess = Public`
Matlab documentation of property attributes.
Default: char.empty("")

Definition at line 402 of file amimodel.m.

9.25.4.36 recompile

```
recompile = false
```

Note

This property has non-standard access specifiers: `SetAccess = Private, GetAccess = Public`
Matlab documentation of property attributes.
Default: false

Definition at line 413 of file amimodel.m.

9.25.4.37 cfun

```
cfun = struct.empty("")
```

Note

This property has non-standard access specifiers: `SetAccess = Private, GetAccess = Public`
`Matlab documentation of property attributes.`
Default: struct.empty("")

Definition at line 424 of file amimodel.m.

9.25.4.38 o2flag

```
o2flag = 0
```

Note

This property has non-standard access specifiers: `SetAccess = Private, GetAccess = Public`
`Matlab documentation of property attributes.`
Default: 0

Definition at line 436 of file amimodel.m.

9.25.4.39 z2event

```
z2event = double.empty("")
```

Default: double.empty("")

Definition at line 455 of file amimodel.m.

9.25.4.40 splineflag

```
splineflag = false
```

Default: false

Definition at line 463 of file amimodel.m.

9.25.4.41 minflag

```
minflag = false
```

Default: false

Definition at line 471 of file amimodel.m.

9.25.4.42 maxflag

```
maxflag = false
```

Default: false

Definition at line 479 of file amimodel.m.

9.25.4.43 nw

```
nw = 0
```

Default: 0

Definition at line 487 of file amimodel.m.

9.25.4.44 ndwdx

```
ndwdx = 0
```

Default: 0

Definition at line 496 of file amimodel.m.

9.25.4.45 ndwdp

```
ndwdp = 0
```

Default: 0

Definition at line 504 of file amimodel.m.

9.26 amioption Class Reference

AMIOPTION provides an option container to pass simulation parameters to the simulation routine.

Inheritance diagram for amioption:

Collaboration diagram for amioption:

Public Member Functions

- amioption (matlabtypesubstitute varargin)

  amioptions Construct a new amioptions object OPTS = amioption() creates a set of options with each option set to its default value.

Public Attributes

- matlabtypesubstitute atol = 1e-16

  absolute integration tolerace
- matlabtypesubstitute rtol = 1e-8

  relative integration tolerace
- matlabtypesubstitute maxsteps = 1e4

  maximum number of integration steps
- matlabtypesubstitute quad_atol = 1e-12

absolute integration tolerace

- matlabtypesubstitute quad_rtol = 1e-8

  relative integration tolerace
- matlabtypesubstitute maxstepsB = 0

  maximum number of integration steps
- matlabtypesubstitute sens_ind = double.empty("")

  index of parameters for which the sensitivities are computed
- matlabtypesubstitute qpositivex = double.empty("")

  index of states for which positivity should be enforced
- matlabtypesubstitute tstart = 0

  starting time of the simulation
- matlabtypesubstitute lmm = 2

  linear multistep method.
- matlabtypesubstitute iter = 2

  iteration method for linear multistep.
- matlabtypesubstitute linsol = 9

  linear solver
- matlabtypesubstitute stldet = true

  stability detection flag
- matlabtypesubstitute interpType = 1

  interpolation type
- matlabtypesubstitute ism = 1

  forward sensitivity mode
- matlabtypesubstitute sensi_meth = 1

  sensitivity method
- matlabtypesubstitute sensi = 0

  sensitivity order
- matlabtypesubstitute nmaxevent = 10

  number of reported events
- matlabtypesubstitute ordering = 0

  reordering of states
- matlabtypesubstitute ss = 0

  steady state sensitivity flag
- matlabtypesubstitute x0 = double.empty("")

  custom initial state
- matlabtypesubstitute sx0 = double.empty("")

  custom initial sensitivity
- matlabtypesubstitute newton_precon = 1

  newton solver: preconditioning method (0 = none, 1 = diagonal, 2 = incomplete LU)
- matlabtypesubstitute newton_maxsteps = 40

  newton solver: maximum newton steps
- matlabtypesubstitute newton_maxlinsteps = 100

  newton solver: maximum linear steps
- matlabtypesubstitute newton_preeq = false

  preequilibration of system via newton solver
- matlabtypesubstitute z2event = double.empty("")

  mapping of event ouputs to events
- matlabtypesubstitute pscale = ""

  parameter scaling Valid options are "log","log10" and "lin" for log, log10 or unscaled parameters p use "" for default as specified in the model (fallback: `lin`)

9.26.1 Detailed Description

Definition at line 17 of file amioption.m.

9.26.2 Constructor & Destructor Documentation

9.26.2.1 amioption()

```
amioption (
            matlabtypesubstitute varargin )
```

OPTS = amioption(PARAM, VAL, ...) creates a set of options with the named parameters altered with the specified values.

OPTS = amioption(OLDOPTS, PARAM, VAL, ...) creates a copy of OLDOPTS with the named parameters altered with the specified value

Note: to see the parameters, check the documentation page for amioption

Parameters

varargin	input to construct amioption object, see function function description

Definition at line 259 of file amioption.m.

9.26.3 Member Data Documentation

9.26.3.1 atol

```
atol = 1e-16
```

Default: 1e-16

Definition at line 28 of file amioption.m.

9.26.3.2 rtol

```
rtol = 1e-8
```

Default: 1e-8

Definition at line 36 of file amioption.m.

9.26.3.3 maxsteps

```
maxsteps = 1e4
```

Default: 1e4

Definition at line 44 of file amioption.m.

9.26.3.4 quad_atol

```
quad_atol = 1e-12
```

Default: 1e-12

Definition at line 52 of file amioption.m.

9.26.3.5 quad_rtol

```
quad_rtol = 1e-8
```

Default: 1e-8

Definition at line 60 of file amioption.m.

9.26.3.6 maxstepsB

```
maxstepsB = 0
```

Default: 0

Definition at line 68 of file amioption.m.

9.26.3.7 sens_ind

```
sens_ind = double.empty("")
```

Default: double.empty("")

Definition at line 76 of file amioption.m.

9.26.3.8 qpositivex

```
qpositivex = double.empty("")
```

Default: double.empty("")

Definition at line 84 of file amioption.m.

9.26.3.9 tstart

```
tstart = 0
```

Default: 0

Definition at line 92 of file amioption.m.

9.26.3.10 lmm

```
lmm = 2
```

Default: 2

Definition at line 100 of file amioption.m.

9.26.3.11 iter

```
iter = 2
```

Default: 2

Definition at line 108 of file amioption.m.

9.26.3.12 linsol

```
linsol = 9
```

Default: 9

Definition at line 116 of file amioption.m.

9.26.3.13 stldet

```
stldet = true
```

Default: true

Definition at line 124 of file amioption.m.

9.26.3.14 interpType

```
interpType = 1
```

Default: 1

Definition at line 132 of file amioption.m.

9.26.3.15 ism

```
ism = 1
```

Default: 1

Definition at line 140 of file amioption.m.

9.26.3.16 sensi_meth

```
sensi_meth = 1
```

Default: 1

Note

This property has custom functionality when its value is changed.

Definition at line 148 of file amioption.m.

9.26.3.17 sensi

```
sensi = 0
```

Default: 0

Note

This property has custom functionality when its value is changed.

Definition at line 156 of file amioption.m.

9.26.3.18 nmaxevent

```
nmaxevent = 10
```

Default: 10

Definition at line 164 of file amioption.m.

9.26.3.19 ordering

```
ordering = 0
```

Default: 0

Definition at line 172 of file amioption.m.

9.26.3.20 ss

```
ss = 0
```

Default: 0

Definition at line 180 of file amioption.m.

9.26.3.21 x0

```
x0 = double.empty("")
```

Default: double.empty("")

Definition at line 188 of file amioption.m.

9.26.3.22 sx0

```
sx0 = double.empty("")
```

Default: double.empty("")

Definition at line 196 of file amioption.m.

9.26.3.23 newton_precon

```
newton_precon = 1
```

Default: 1

Note

This property has custom functionality when its value is changed.

Definition at line 204 of file amioption.m.

9.26.3.24 newton_maxsteps

```
newton_maxsteps = 40
```

Default: 40

Note

This property has custom functionality when its value is changed.

Definition at line 213 of file amioption.m.

9.26.3.25 newton_maxlinsteps

```
newton_maxlinsteps = 100
```

Default: 100

Note

This property has custom functionality when its value is changed.

Definition at line 221 of file amioption.m.

9.26.3.26 newton_preeq

```
newton_preeq = false
```

Default: false

Note

This property has custom functionality when its value is changed.

Definition at line 229 of file amioption.m.

9.26.3.27 z2event

```
z2event = double.empty("")
```

Default: double.empty("")

Definition at line 237 of file amioption.m.

9.26.3.28 pscale

```
pscale = ""
```

Default: ""

Note

This property has custom functionality when its value is changed.

Definition at line 245 of file amioption.m.

9.27 amised Class Reference

AMISED is a container for SED-ML objects.

Inheritance diagram for amised:

Collaboration diagram for amised:

Public Member Functions

- amised (matlabtypesubstitute sedname)

  amised reads in an SEDML document using the JAVA binding of of libSEDML

Public Attributes

- matlabtypesubstitute model = struct("'event',[ ],'sym',[ ]")

  amimodel from the specified model
- matlabtypesubstitute modelname = {""}

  cell array of model identifiers
- matlabtypesubstitute sedml = struct.empty("")

  stores the struct tree from the xml definition
- matlabtypesubstitute outputcount = "[ ]"

  count the number of outputs per model

- matlabtypesubstitute varidx = "[ ]"

  indexes for dataGenerators
- matlabtypesubstitute varsym = sym("[ ]")

  symbolic expressions for variables
- matlabtypesubstitute datasym = sym("[ ]")

  symbolic expressions for data

9.27.1 Detailed Description

Definition at line 17 of file amised.m.

9.27.2 Constructor & Destructor Documentation

9.27.2.1 amised()

```
amised (
            matlabtypesubstitute sedname )
```

Parameters

sedname	name/path of the SEDML document

Definition at line 112 of file amised.m.

Here is the call graph for this function:

9.27.3 Member Data Documentation

9.27.3.1 model

```
model = struct("'event',[],'sym',[]")
```

Note

This property has non-standard access specifiers: `SetAccess = Private, GetAccess = Public`
`Matlab documentation of property attributes.`
Default: struct("'event',[ ],'sym',[ ]")

Definition at line 27 of file amised.m.

9.27.3.2 modelname

```
modelname = {""}
```

Note

This property has non-standard access specifiers: `SetAccess = Private, GetAccess = Public`
`Matlab documentation of property attributes.`
Default: {""}

Definition at line 38 of file amised.m.

9.27.3.3 sedml

```
sedml = struct.empty("")
```

Note

This property has non-standard access specifiers: `SetAccess = Private, GetAccess = Public`
`Matlab documentation of property attributes.`
Default: struct.empty("")

Definition at line 49 of file amised.m.

9.27.3.4 outputcount

```
outputcount = "[ ]"
```

Note

This property has non-standard access specifiers: `SetAccess = Private, GetAccess = Public`
`Matlab documentation of property attributes.`
Default: "[ ]"

Definition at line 60 of file amised.m.

9.27.3.5 varidx

```
varidx = "[]"
```

Note

This property has non-standard access specifiers: `SetAccess = Private, GetAccess = Public`
`Matlab documentation of property attributes.`
Default: "[]"

Definition at line 71 of file amised.m.

9.27.3.6 varsym

```
varsym = sym("[]")
```

Note

This property has non-standard access specifiers: `SetAccess = Private, GetAccess = Public`
`Matlab documentation of property attributes.`
Default: sym("[]")

Definition at line 82 of file amised.m.

9.27.3.7 datasym

```
datasym = sym("[]")
```

Note

This property has non-standard access specifiers: `SetAccess = Private, GetAccess = Public`
`Matlab documentation of property attributes.`
Default: sym("[]")

Definition at line 93 of file amised.m.

9.28 cell Class Reference

A MatLab cell array or matrix.

9.28.1 Detailed Description

This class is an artificially created class in doxygen to allow more precise type declarations

9.29 char Class Reference

A MatLab character array.

9.29.1 Detailed Description

This class is an artificially created class in doxygen to allow more precise type declarations and represents string-like types.

9.30 colvec Class Reference

A matlab column vector.

9.30.1 Detailed Description

This class is an artificially created class in doxygen to allow more precise type declarations

9.31 double Class Reference

A double value.

9.31.1 Detailed Description

This class is an artificially created class in doxygen to allow more precise type declarations. The MatLab type associated with this class is double.

9.32 function_handle Class Reference

A MatLab function handle.

9.32.1 Detailed Description

This class is an artificially created class in doxygen to allow more precise type declarations

9.33 handle Class Reference

Matlab's base handle class (documentation generation substitute)

Inheritance diagram for handle:

Public Attributes

- matlabtypesubstitute addlistener

  Creates a listener for the specified event and assigns a callback function to execute when the event occurs.
- matlabtypesubstitute notify

  Broadcast a notice that a specific event is occurring on a specified handle object or array of handle objects.
- matlabtypesubstitute delete

  Handle object destructor method that is called when the object's lifecycle ends.
- matlabtypesubstitute disp

  Handle object disp method which is called by the display method. See the MATLAB disp function.
- matlabtypesubstitute display

  Handle object display method called when MATLAB software interprets an expression returning a handle object that is not terminated by a semicolon. See the MATLAB display function.
- matlabtypesubstitute findobj

  Finds objects matching the specified conditions from the input array of handle objects.
- matlabtypesubstitute findprop

  Returns a meta.property objects associated with the specified property name.
- matlabtypesubstitute fields

  Returns a cell array of string containing the names of public properties.
- matlabtypesubstitute fieldnames

  Returns a cell array of string containing the names of public properties. See the MATLAB fieldnames function.
- matlabtypesubstitute isvalid

  Returns a logical array in which elements are true if the corresponding elements in the input array are valid handles. This method is Sealed so you cannot override it in a handle subclass.
- matlabtypesubstitute eq

  Relational functions example. See details for more information.
- matlabtypesubstitute transpose

  Transposes the elements of the handle object array.
- matlabtypesubstitute permute

  Rearranges the dimensions of the handle object array. See the MATLAB permute function.
- matlabtypesubstitute reshape

  changes the dimensions of the handle object array to the specified dimensions. See the MATLAB reshape function.
- matlabtypesubstitute sort

  sort the handle objects in any array in ascending or descending order.

9.33.1 Detailed Description

As doxygen does not know the class "handle" from itself, many classes do not get rendered within the documentation and the correct root class is not even displayed. This workaround guarantees a correct (also graphical) representation of the class hierarchy.

Note here that by having the type handle it could also mean to have a vector or matrix of handles.

Definition at line 106 of file class_substitutes.c.

9.33.2 Member Data Documentation

9.33.2.1 addlistener

```
matlabtypesubstitute addlistener
```

See also

notify

Definition at line 121 of file class_substitutes.c.

9.33.2.2 eq

```
matlabtypesubstitute eq
```

Other possible relational operators:

-ne -lt -le -gt -ge

Relational functions return a logical array of the same size as the pair of input handle object arrays. Comparisons use a number associated with each handle. You can assume that the same two handles will compare as equal and the repeated comparison of any two handles will yield the same result in the same MATLAB session. Different handles are always not-equal. The order of handles is purely arbitrary, but consistent.

Definition at line 182 of file class_substitutes.c.

9.33.2.3 sort

```
matlabtypesubstitute sort
```

The order of handles is purely arbitrary, but reproducible in a given MATLAB session. See the MATLAB sort function.

Definition at line 204 of file class_substitutes.c.

9.34 integer Class Reference

An integer value.

9.34.1 Detailed Description

This class is an artificially created class in doxygen to allow more precise type declarations. Matlab types associated with this class are all int-types (int8, uint8 etc).

9.35 logical Class Reference

A boolean value.

9.35.1 Detailed Description

This class can be seen as synonym for boolean values/flags used inside classes. In order to stick with matlab conventions/datatypes, this class was named logical instead of bool or boolean.

This class is an artificially created class in doxygen to allow more precise type declarations

9.36 matrix Class Reference

A matlab matrix.

Inheritance diagram for matrix:

9.36.1 Detailed Description

This class is an artificially created class in doxygen to allow more precise type declarations

Definition at line 73 of file class_substitutes.c.

9.37 optsym Class Reference

OPTSYM is an auxiliary class to gain access to the private symbolic property `s` which is necessary to be able to call symobj::optimize on it.

Inheritance diagram for optsym:

Collaboration diagram for optsym:

Public Member Functions

- optsym (::sym symbol)

  optsym converts the symbolic object into a optsym object
- mlhsInnerSubst<::sym > getoptimized ()

  getoptimized calls symobj::optimize on the optsym object

9.37.1 Detailed Description

Definition at line 17 of file optsym.m.

9.37.2 Constructor & Destructor Documentation

9.37.2.1 optsym()

```
optsym (
            ::sym symbol )
```

Parameters

symbol	symbolic object

Definition at line 32 of file optsym.m.

9.37.3 Member Function Documentation

9.37.3.1 getoptimized()

```
mlhsInnerSubst<::sym > getoptimized ( )
```

Return values

out	optimized symbolic object

Definition at line 42 of file optsym.m.

9.38 rowvec Class Reference

A matlab row vector.

9.38.1 Detailed Description

This class is an artificially created class in doxygen to allow more precise type declarations

9.39 SBMLode Class Reference

SBMLMODEL provides an intermediate container between the SBML definition and an amimodel object.

Inheritance diagram for SBMLode:

Collaboration diagram for SBMLode:

Public Member Functions

- SBMLode (matlabtypesubstitute filename)

  SBMLode extracts information from an SBML definition and stores it in a symbolic format.
- noret::substitute importSBML (matlabtypesubstitute filename)

  importSBML parses information from the SBML definition and populates the SBMLode object from this information.
- noret::substitute checkODE ()

  checkODE checks whether the length of various variable names exceeds namelengthmax (would cause troube with symbolic processing later on).
- noret::substitute writeAMICI (matlabtypesubstitute modelname)

  writeAMICI writes the symbolic information from an SBMLode object into an AMICI model definition file

Public Attributes

- matlabtypesubstitute state = sym.empty("")

  states
- matlabtypesubstitute observable = sym.empty("")

  observables
- matlabtypesubstitute observable_name = sym.empty("")

  names of observables
- matlabtypesubstitute param = sym.empty("")

  parameter names
- matlabtypesubstitute parameter = sym.empty("")

  parameter expressions
- matlabtypesubstitute constant = sym.empty("")

  constants
- matlabtypesubstitute reaction = sym.empty("")

  reactions
- matlabtypesubstitute compartment = sym.empty("")

  compartments
- matlabtypesubstitute volume = sym.empty("")

  compartment volumes
- matlabtypesubstitute kvolume = sym.empty("")

  condition volumes
- matlabtypesubstitute initState = sym.empty("")

initial condition of states

- matlabtypesubstitute condition = sym.empty("")

  condition
- matlabtypesubstitute flux = sym.empty("")

  reaction fluxes
- matlabtypesubstitute stochiometry = sym.empty("")

  reaction stochiometry
- matlabtypesubstitute xdot = sym.empty("")

  right hand side of reconstructed differential equation
- matlabtypesubstitute trigger = sym.empty("")

  event triggers
- matlabtypesubstitute bolus = sym.empty("")

  event boli
- matlabtypesubstitute funmath = cell.empty("")

  mathematical experessions for function
- matlabtypesubstitute funarg = cell.empty("")

  string function signature
- matlabtypesubstitute time_symbol = char.empty("")

  symbol of time
- matlabtypesubstitute pnom = double.empty("")

  nominal parameters
- matlabtypesubstitute knom = double.empty("")

  nominal conditions

9.39.1 Detailed Description

Definition at line 17 of file SBMLode.m.

9.39.2 Constructor & Destructor Documentation

9.39.2.1 SBMLode()

```
SBMLode (
            matlabtypesubstitute filename )
```

Parameters

filename	target name of the model (excluding the suffix .xml/.sbml)

Definition at line 207 of file SBMLode.m.

9.39.3 Member Function Documentation

9.39.3.1 importSBML()

```
noret::substitute importSBML (
            matlabtypesubstitute filename )
```

Parameters

filename	target name of the model

Return values

filename	void

Definition at line 18 of file importSBML.m.

Here is the call graph for this function:

9.39.3.2 checkODE()

```
noret::substitute checkODE ( )
```

Return values

void	

Definition at line 18 of file checkODE.m.

9.39.3.3 writeAMICI()

```
noret::substitute writeAMICI (
            matlabtypesubstitute modelname )
```

Parameters

modelname	target name of the model (_syms.m will be appended to the name)

Return values

modelname	void

Definition at line 18 of file writeAMICI.m.

9.39.4 Member Data Documentation

9.39.4.1 state

```
state = sym.empty("")
```

Default: sym.empty("")

Definition at line 28 of file SBMLode.m.

9.39.4.2 observable

```
observable = sym.empty("")
```

Default: sym.empty("")

Definition at line 36 of file SBMLode.m.

9.39.4.3 observable_name

```
observable_name = sym.empty("")
```

Default: sym.empty("")

Definition at line 44 of file SBMLode.m.

9.39.4.4 param

```
param = sym.empty("")
```

Default: sym.empty("")

Definition at line 52 of file SBMLode.m.

9.39.4.5 parameter

```
parameter = sym.empty("")
```

Default: sym.empty("")

Definition at line 60 of file SBMLode.m.

9.39.4.6 constant

```
constant = sym.empty("")
```

Default: sym.empty("")

Definition at line 68 of file SBMLode.m.

9.39.4.7 reaction

```
reaction = sym.empty("")
```

Default: sym.empty("")

Definition at line 76 of file SBMLode.m.

9.39.4.8 compartment

```
compartment = sym.empty("")
```

Default: sym.empty("")

Definition at line 84 of file SBMLode.m.

9.39.4.9 volume

```
volume = sym.empty("")
```

Default: sym.empty("")

Definition at line 92 of file SBMLode.m.

9.39.4.10 kvolume

```
kvolume = sym.empty("")
```

Default: sym.empty("")

Definition at line 100 of file SBMLode.m.

9.39.4.11 initState

```
initState = sym.empty("")
```

Default: sym.empty("")

Definition at line 108 of file SBMLode.m.

9.39.4.12 condition

```
condition = sym.empty("")
```

Default: sym.empty("")

Definition at line 116 of file SBMLode.m.

9.39.4.13 flux

```
flux = sym.empty("")
```

Default: sym.empty("")

Definition at line 124 of file SBMLode.m.

9.39.4.14 stochiometry

```
stochiometry = sym.empty("")
```

Default: sym.empty("")

Definition at line 132 of file SBMLode.m.

9.39.4.15 xdot

```
xdot = sym.empty("")
```

Default: sym.empty("")

Definition at line 140 of file SBMLode.m.

9.39.4.16 trigger

```
trigger = sym.empty("")
```

Default: sym.empty("")

Definition at line 148 of file SBMLode.m.

9.39.4.17 bolus

```
bolus = sym.empty("")
```

Default: sym.empty("")

Definition at line 156 of file SBMLode.m.

9.39.4.18 funmath

```
funmath = cell.empty("")
```

Default: cell.empty("")

Definition at line 164 of file SBMLode.m.

9.39.4.19 funarg

```
funarg = cell.empty("")
```

Default: cell.empty("")

Definition at line 172 of file SBMLode.m.

9.39.4.20 time_symbol

```
time_symbol = char.empty("")
```

Default: char.empty("")

Definition at line 180 of file SBMLode.m.

9.39.4.21 pnom

```
pnom = double.empty("")
```

Default: double.empty("")

Definition at line 188 of file SBMLode.m.

9.39.4.22 knom

```
knom = double.empty("")
```

Default: double.empty("")

Definition at line 196 of file SBMLode.m.

9.40 sparsematrix Class Reference

A matlab sparse matrix.

Inheritance diagram for sparsematrix:

Collaboration diagram for sparsematrix:

9.40.1 Detailed Description

This class is an artificially created class in doxygen to allow more precise type declarations

Definition at line 81 of file class_substitutes.c.

9.41 struct Class Reference

A MatLab struct.

9.41.1 Detailed Description

This class is an artificially created class in doxygen to allow more precise type declarations

9.42 symbolic Class Reference

9.42.1 Detailed Description

Definition at line 92 of file class_substitutes.c.

9.43 varargin Class Reference

A variable number of input arguments.

9.43.1 Detailed Description

This class is an artificially created class in doxygen to allow more precise type declarations.

For more information about the varargin argument see the `MatLab documentation on varargin`.

9.44 varargout Class Reference

A variable number of output arguments.

9.44.1 Detailed Description

This class is an artificially created class in doxygen to allow more precise type declarations.

For more information about the varargout argument see the `MatLab documentation on varargout`.

10 File Documentation

10.1 matlab/amiwrap.m File Reference

AMIWRAP generates c++ mex files for the simulation of systems of differential equations via CVODES and IDAS.

Functions

- noret::substitute amiwrap (matlabtypesubstitute varargin)

  AMIWRAP generates c++ mex files for the simulation of systems of differential equations via CVODES and IDAS.

10.1.1 Function Documentation

10.1.1.1 amiwrap()

```
noret::substitute amiwrap (
            matlabtypesubstitute varargin )
```

Parameters

varargin	`amiwrap ( modelname, symfun, tdir, o2flag )` *Required Parameters for varargin:* • modelname specifies the name of the model which will be later used for the naming of the simulation file • symfun specifies a function which executes model definition see Model Definition for details • tdir target directory where the simulation file should be placed **Default:** $AMICIDIR/models/modelname • o2flag boolean whether second order sensitivities should be enabled **Default:** false

Return values

o2flag	void

Definition at line 17 of file amiwrap.m.

10.2 matlab/SBML2AMICI.m File Reference

SBML2AMICI generates AMICI model definition files from SBML.

Functions

- noret::substitute SBML2AMICI (matlabtypesubstitute filename, matlabtypesubstitute modelname)

  SBML2AMICI generates AMICI model definition files from SBML.

10.2.1 Function Documentation

10.2.1.1 SBML2AMICI()

```
noret::substitute SBML2AMICI (
            matlabtypesubstitute filename,
            matlabtypesubstitute modelname )
```

Parameters

filename	name of the SBML file (withouth extension)
modelname	name of the model, this will define the name of the output file (default: input filename)

Return values

modelname	void

Definition at line 17 of file SBML2AMICI.m.

Here is the caller graph for this function:

10.3 matlab/SBMLimporter/computeBracketLevel.m File Reference

Compute the bracket level for the input string cstr. The bracket level is computed for every char in cstr and indicates how many brackets have been opened up to this point. The bracket level is useful to parse the arguments of functions in cstr. For this purpose functions will have the same bracket level as the opening bracket of the corresponding function call.

Functions

- mlhsInnerSubst<::*int > computeBracketLevel (::*char cstr)

  Compute the bracket level for the input string cstr. The bracket level is computed for every char in cstr and indicates how many brackets have been opened up to this point. The bracket level is useful to parse the arguments of functions in cstr. For this purpose functions will have the same bracket level as the opening bracket of the corresponding function call.

10.3.1 Function Documentation

10.3.1.1 computeBracketLevel()

```
mlhsInnerSubst<::*int > computeBracketLevel (
            ::*char cstr )
```

Parameters

cstr	input string

Return values

brl	bracket levels

Definition at line 17 of file computeBracketLevel.m.

Here is the caller graph for this function:

10.4 matlab/symbolic/am_and.m File Reference

am_and is the amici implementation of the symbolic and function

Functions

- mlhsInnerSubst< matlabtypesubstitute > am_and (::sym a,::sym b)

  am_and is the amici implementation of the symbolic and function

10.4.1 Function Documentation

10.4.1.1 am_and()

```
mlhsInnerSubst< matlabtypesubstitute > am_and (
            ::sym a,
            ::sym b )
```

Parameters

a	first input parameter
b	second input parameter

Return values

fun	logical value, negative for false, positive for true

Definition at line 17 of file am_and.m.

Here is the call graph for this function:

Here is the caller graph for this function:

10.5 matlab/symbolic/am_eq.m File Reference

am_eq is currently a placeholder that simply produces an error message

Functions

- mlhsInnerSubst< matlabtypesubstitute > am_eq (matlabtypesubstitute varargin)

  am_eq is currently a placeholder that simply produces an error message

10.5.1 Function Documentation

10.5.1.1 am_eq()

```
mlhsInnerSubst< matlabtypesubstitute > am_eq (
            matlabtypesubstitute varargin )
```

Parameters

varargin	elements for chain of equalities

Return values

fun	logical value, negative for false, positive for true

Definition at line 17 of file am_eq.m.

10.6 matlab/symbolic/am_ge.m File Reference

am_ge is the amici implementation of the n-ary mathml greaterorequal function this is an n-ary function, for more than 2 input parameters it will check whether and(varargin{1} >= varargin{2},varargin{2} >= varargin{3},...)

Functions

- mlhsInnerSubst< matlabtypesubstitute > am_ge (::sym varargin)

  am_ge is the amici implementation of the n-ary mathml greaterorequal function this is an n-ary function, for more than 2 input parameters it will check whether and(varargin{1} >= varargin{2},varargin{2} >= varargin{3},...)

10.6.1 Function Documentation

10.6.1.1 am_ge()

```
mlhsInnerSubst< matlabtypesubstitute > am_ge (
            ::sym varargin )
```

Parameters

varargin	chain of input parameters

Return values

fun	a >= b logical value, negative for false, positive for true

Definition at line 17 of file am_ge.m.

Here is the call graph for this function:

10.7 matlab/symbolic/am_gt.m File Reference

am_gt is the amici implementation of the n-ary mathml greaterthan function this is an n-ary function, for more than 2 input parameters it will check whether and(varargin{1} > varargin{2},varargin{2} > varargin{3},...)

Functions

- mlhsInnerSubst< matlabtypesubstitute > am_gt (::sym varargin)

  am_gt is the amici implementation of the n-ary mathml greaterthan function this is an n-ary function, for more than 2 input parameters it will check whether and(varargin{1} > varargin{2},varargin{2} > varargin{3},...)

10.7.1 Function Documentation

10.7.1.1 am_gt()

```
mlhsInnerSubst< matlabtypesubstitute > am_gt (
            ::sym varargin )
```

Parameters

varargin	chain of input parameters

Return values

fun	a > b logical value, negative for false, positive for true

Definition at line 17 of file am_gt.m.

Here is the call graph for this function:

10.8 matlab/symbolic/am_if.m File Reference

am_if is the amici implementation of the symbolic if function

Functions

- mlhsInnerSubst< matlabtypesubstitute > am_if (::sym condition,::sym truepart,::sym falsepart)

  am_if is the amici implementation of the symbolic if function

10.8.1 Function Documentation

10.8.1.1 am_if()

```
mlhsInnerSubst< matlabtypesubstitute > am_if (
            ::sym condition,
            ::sym truepart,
            ::sym falsepart )
```

Parameters

condition	logical value
truepart	value if condition is true
falsepart	value if condition is false

Return values

fun	if condition is true truepart, else falsepart

Definition at line 17 of file am_if.m.

Here is the caller graph for this function:

10.9 matlab/symbolic/am_le.m File Reference

am_le is the amici implementation of the n-ary mathml lessorequal function this is an n-ary function, for more than 2 input parameters it will check whether and(varargin{1} <= varargin{2},varargin{2} <= varargin{3},...)

Functions

- mlhsInnerSubst< matlabtypesubstitute > am_le (::sym varargin)

  am_le is the amici implementation of the n-ary mathml lessorequal function this is an n-ary function, for more than 2 input parameters it will check whether and(varargin{1} <= varargin{2},varargin{2} <= varargin{3},...)

10.9.1 Function Documentation

10.9.1.1 am_le()

```
mlhsInnerSubst< matlabtypesubstitute > am_le (
            ::sym varargin )
```

Parameters

varargin	chain of input parameters

Return values

fun	a <= b logical value, negative for false, positive for true

Definition at line 17 of file am_le.m.

Here is the call graph for this function:

10.10 matlab/symbolic/am_lt.m File Reference

am_lt is the amici implementation of the n-ary mathml lessthan function this is an n-ary function, for more than 2 input parameters it will check whether and(varargin{1} < varargin{2},varargin{2} < varargin{3},...)

Functions

- mlhsInnerSubst< matlabtypesubstitute > am_lt (::sym varargin)

  am_lt is the amici implementation of the n-ary mathml lessthan function this is an n-ary function, for more than 2 input parameters it will check whether and(varargin{1} < varargin{2},varargin{2} < varargin{3},...)

10.10.1 Function Documentation

10.10.1.1 am_lt()

```
mlhsInnerSubst< matlabtypesubstitute > am_lt (
            ::sym varargin )
```

Parameters

varargin	chain of input parameters

Return values

fun	a < b logical value, negative for false, positive for true

Definition at line 17 of file am_lt.m.

Here is the call graph for this function:

10.11 matlab/symbolic/am_max.m File Reference

am_max is the amici implementation of the symbolic max function

Functions

- mlhsInnerSubst< matlabtypesubstitute > am_max (::sym a,::sym b)
  am_max is the amici implementation of the symbolic max function

10.11.1 Function Documentation

10.11.1.1 am_max()

```
mlhsInnerSubst< matlabtypesubstitute > am_max (
            ::sym a,
            ::sym b )
```

Parameters

a	first input parameter
b	second input parameter

Return values

fun	maximum of a and b

Definition at line 17 of file am_max.m.

Here is the caller graph for this function:

10.12 matlab/symbolic/am_min.m File Reference

am_min is the amici implementation of the symbolic min function

Functions

- mlhsInnerSubst< matlabtypesubstitute > am_min (::sym a,::sym b)

  am_min is the amici implementation of the symbolic min function

10.12.1 Function Documentation

10.12.1.1 am_min()

```
mlhsInnerSubst< matlabtypesubstitute > am_min (
            ::sym a,
            ::sym b )
```

Parameters

a	first input parameter
b	second input parameter

Return values

fun	minimum of a and b

Definition at line 17 of file am_min.m.

Here is the call graph for this function:

Here is the caller graph for this function:

10.13 matlab/symbolic/am_or.m File Reference

am_or is the amici implementation of the symbolic or function

Functions

- mlhsInnerSubst< matlabtypesubstitute > am_or (::sym a,::sym b)
  am_or is the amici implementation of the symbolic or function

10.13.1 Function Documentation

10.13.1.1 am_or()

```
mlhsInnerSubst< matlabtypesubstitute > am_or (
            ::sym a,
            ::sym b )
```

Parameters

a	first input parameter
b	second input parameter

Return values

fun	logical value, negative for false, positive for true

Definition at line 17 of file am_or.m.

Here is the call graph for this function:

Here is the caller graph for this function:

10.14 matlab/symbolic/am_piecewise.m File Reference

am_piecewise is the amici implementation of the mathml piecewise function

Functions

- mlhsInnerSubst< matlabtypesubstitute > am_piecewise (matlabtypesubstitute piece, matlabtypesubstitute condition, matlabtypesubstitute default)

  am_piecewise is the amici implementation of the mathml piecewise function

10.14.1 Function Documentation

10.14.1.1 am_piecewise()

```
mlhsInnerSubst< matlabtypesubstitute > am_piecewise (
            matlabtypesubstitute piece,
            matlabtypesubstitute condition,
            matlabtypesubstitute default )
```

Parameters

piece	value if condition is true
condition	logical value
default	value if condition is false

Return values

fun	return value, piece if condition is true, default if not

Definition at line 17 of file am_piecewise.m.

Here is the call graph for this function:

10.15 matlab/symbolic/am_stepfun.m File Reference

am_stepfun is the amici implementation of the step function

Functions

- mlhsInnerSubst< matlabtypesubstitute > am_stepfun (::sym t, matlabtypesubstitute tstart, matlabtypesubstitute vstart, matlabtypesubstitute tend, matlabtypesubstitute vend)

  am_stepfun is the amici implementation of the step function

10.15.1 Function Documentation

10.15.1.1 am_stepfun()

```
mlhsInnerSubst< matlabtypesubstitute > am_stepfun (
            ::sym t,
            matlabtypesubstitute tstart,
            matlabtypesubstitute vstart,
            matlabtypesubstitute tend,
            matlabtypesubstitute vend )
```

Parameters

t	input variable
tstart	input variable value at which the step starts
vstart	value during the step
tend	input variable value at which the step end
vend	value after the step

Return values

fun	0 before tstart, vstart between tstart and tend and vend after tend

Definition at line 17 of file am_stepfun.m.

10.16 matlab/symbolic/am_xor.m File Reference

am_xor is the amici implementation of the symbolic exclusive or function

Functions

- mlhsInnerSubst< matlabtypesubstitute > am_xor (::sym a,::sym b)
  am_xor is the amici implementation of the symbolic exclusive or function

10.16.1 Function Documentation

10.16.1.1 am_xor()

```
mlhsInnerSubst< matlabtypesubstitute > am_xor (
            ::sym a,
            ::sym b )
```

Parameters

a	first input parameter
b	second input parameter

Return values

fun	logical value, negative for false, positive for true

Definition at line 17 of file am_xor.m.

Here is the call graph for this function:

10.17 src/amici.cpp File Reference

core routines for integration

```
#include "amici/amici.h"
#include "amici/backwardproblem.h"
#include "amici/forwardproblem.h"
#include "amici/misc.h"
#include <sundials/sundials_types.h>
#include <cvodes/cvodes.h>
#include <type_traits>
#include <cassert>
#include <cstdlib>
#include <cstring>
#include <cstdarg>
#include <memory>
#include <cmath>
```

Include dependency graph for amici.cpp:

Macros

- #define _USE_MATH_DEFINES
- #define M_PI 3.14159265358979323846

Functions

- std::unique_ptr< ReturnData > **runAmiciSimulation** (Solver &solver, const ExpData *edata, Model &model)
- void **printErrMsgIdAndTxt** (const char *identifier, const char *format,...)
- void **printWarnMsgIdAndTxt** (const char *identifier, const char *format,...)

10.17.1 Macro Definition Documentation

10.17.1.1 _USE_MATH_DEFINES

```
#define _USE_MATH_DEFINES
```

MS definition of PI and other constants

Definition at line 23 of file amici.cpp.

10.17.1.2 M_PI

```
#define M_PI 3.14159265358979323846
```

define PI if we still have no definition

Definition at line 27 of file amici.cpp.

10.17.2 Function Documentation

10.17.2.1 runAmiciSimulation()

```
std::unique_ptr< ReturnData > runAmiciSimulation (
            Solver & solver,
            const ExpData * edata,
            Model & model )
```

runAmiciSimulation is the core integration routine. It initializes the solver and runs the forward and backward problem.

Parameters

solver	Solver instance
edata	pointer to experimental data object
model	model specification object

Returns

rdata pointer to return data object

Definition at line 59 of file amici.cpp.

10.17.2.2 printErrMsgIdAndTxt()

```
void printErrMsgIdAndTxt (
            const char * identifier,
            const char * format,
             ...  )
```

printErrMsgIdAndTxt prints a specified error message associated to the specified identifier

Parameters

in	*identifier*	error identifier **Type**: char
in	*format*	string with error message printf-style format
	...	arguments to be formatted

Returns

void

Definition at line 105 of file amici.cpp.

10.17.2.3 printWarnMsgIdAndTxt()

```
void printWarnMsgIdAndTxt (
            const char * identifier,
            const char * format,
             ...  )
```

printErrMsgIdAndTxt prints a specified warning message associated to the specified identifier

Parameters

in	*identifier*	warning identifier **Type**: char
in	*format*	string with error message printf-style format
	...	arguments to be formatted

Returns

void

Definition at line 126 of file amici.cpp.

10.18 src/cblas.cpp File Reference

BLAS routines required by AMICI.

```
#include "amici/defines.h"
#include <cblas.h>
```

Include dependency graph for cblas.cpp:

Functions

- void **amici_dgemm** (AMICI_BLAS_LAYOUT layout, AMICI_BLAS_TRANSPOSE TransA, AMICI_BLAS_TRANSPOSE TransB, const int M, const int N, const int K, const double alpha, const double ∗A, const int lda, const double ∗B, const int ldb, const double beta, double ∗C, const int ldc)
- void **amici_dgemv** (AMICI_BLAS_LAYOUT layout, AMICI_BLAS_TRANSPOSE TransA, const int M, const int N, const double alpha, const double ∗A, const int lda, const double ∗X, const int incX, const double beta, double ∗Y, const int incY)

10.18.1 Function Documentation

10.18.1.1 amici_dgemm()

```
void amici_dgemm (
            AMICI_BLAS_LAYOUT layout,
            AMICI_BLAS_TRANSPOSE TransA,
            AMICI_BLAS_TRANSPOSE TransB,
            const int M,
            const int N,
            const int K,
            const double alpha,
            const double * A,
            const int lda,
            const double * B,
            const int ldb,
            const double beta,
            double * C,
            const int ldc )
```

amici_dgemm provides an interface to the blas matrix matrix multiplication routine dgemm. This routines computes C = alpha∗A∗B + beta∗C with A: [MxK] B:[KxN] C:[MxN]

Parameters

in	*layout*	can be AMICI_BLAS_ColMajor or AMICI_BLAS_RowMajor.
in	*TransA*	flag indicating whether A should be transposed before multiplication
in	*TransB*	flag indicating whether B should be transposed before multiplication
in	*M*	number of rows in A/C
in	*N*	number of columns in B/C
in	*K*	number of rows in B, number of columns in A
in	*alpha*	coefficient alpha
in	*A*	matrix A
in	*lda*	leading dimension of A (m or k)
in	*B*	matrix B
in	*ldb*	leading dimension of B (k or n)
in	*beta*	coefficient beta
in,out	*C*	matrix C
in	*ldc*	leading dimension of C (m or n)

amici_dgemm provides an interface to the CBlas matrix matrix multiplication routine dgemm. This routines computes C = alpha∗A∗B + beta∗C with A: [MxK] B:[KxN] C:[MxN]

Parameters

	layout	memory layout.
	TransA	flag indicating whether A should be transposed before multiplication
	TransB	flag indicating whether B should be transposed before multiplication
	M	number of rows in A/C
	N	number of columns in B/C
	K	number of rows in B, number of columns in A
	alpha	coefficient alpha
	A	matrix A
	lda	leading dimension of A (m or k)
	B	matrix B
	ldb	leading dimension of B (k or n)
	beta	coefficient beta
in,out	*C*	matrix C
	ldc	leading dimension of C (m or n)

Returns

void

Definition at line 44 of file cblas.cpp.

10.18.1.2 amici_dgemv()

```
void amici_dgemv (
            AMICI_BLAS_LAYOUT layout,
            AMICI_BLAS_TRANSPOSE TransA,
```

```
const int M,
const int N,
const double alpha,
const double * A,
const int lda,
const double * X,
const int incX,
const double beta,
double * Y,
const int incY )
```

amici_dgemm provides an interface to the blas matrix vector multiplication routine dgemv. This routines computes y = alpha∗A∗x + beta∗y with A: [MxK] B:[KxN] C:[MxN]

Parameters

in	*layout*	can be AMICI_BLAS_ColMajor or AMICI_BLAS_RowMajor.
in	*TransA*	flag indicating whether A should be transposed before multiplication
in	*M*	number of rows in A
in	*N*	number of columns in A
in	*alpha*	coefficient alpha
in	*A*	matrix A
in	*lda*	leading dimension of A (m or n)
in	*X*	vector X
in	*incX*	increment for entries of X
in	*beta*	coefficient beta
in,out	*Y*	vector Y
in	*incY*	increment for entries of Y

amici_dgemm provides an interface to the CBlas matrix vector multiplication routine dgemv. This routines computes y = alpha∗A∗x + beta∗y with A: [MxN] x:[Nx1] y:[Mx1]

Parameters

	layout	always needs to be AMICI_BLAS_ColMajor.
	TransA	flag indicating whether A should be transposed before multiplication
	M	number of rows in A
	N	number of columns in A
	alpha	coefficient alpha
	A	matrix A
	lda	leading dimension of A (m or n)
	X	vector X
	incX	increment for entries of X
	beta	coefficient beta
in,out	*Y*	vector Y
	incY	increment for entries of Y

Returns

void

Definition at line 73 of file cblas.cpp.

10.19 src/interface_matlab.cpp File Reference

core routines for mex interface

```
#include "amici/interface_matlab.h"
#include "amici/model.h"
#include "amici/exception.h"
#include "amici/edata.h"
#include "amici/returndata_matlab.h"
#include <assert.h>
#include <blas.h>
#include <cstring>
#include <memory>
#include <cmath>
```

Include dependency graph for interface_matlab.cpp:

Macros

- #define _USE_MATH_DEFINES
- #define M_PI 3.14159265358979323846

Enumerations

- enum mexRhsArguments {
  RHS_TIMEPOINTS, **RHS_PARAMETERS**, **RHS_CONSTANTS**, **RHS_OPTIONS**, **RHS_PLIST**, **RHS_XSCALE_UNUSED**, **RHS_INITIALIZATION**, **RHS_DATA**, **RHS_NUMARGS_REQUIRED** = RHS_DATA, **RHS_NUMARGS** }

  The mexFunctionArguments enum takes care of the ordering of mex file arguments (indexing in prhs)

Functions

- int dbl2int (const double x)
- char amici_blasCBlasTransToBlasTrans (AMICI_BLAS_TRANSPOSE trans)
- void **amici_dgemm** (AMICI_BLAS_LAYOUT layout, AMICI_BLAS_TRANSPOSE TransA, AMICI_BLAS_TRANSPOSE TransB, const int M, const int N, const int K, const double alpha, const double ∗A, const int lda, const double ∗B, const int ldb, const double beta, double ∗C, const int ldc)
- void **amici_dgemv** (AMICI_BLAS_LAYOUT layout, AMICI_BLAS_TRANSPOSE TransA, const int M, const int N, const double alpha, const double ∗A, const int lda, const double ∗X, const int incX, const double beta, double ∗Y, const int incY)
- ExpData ∗ **expDataFromMatlabCall** (const mxArray ∗prhs[ ], const Model &model)
- void **setSolverOptions** (const mxArray ∗prhs[ ], int nrhs, Solver &solver)

  setSolverOptions solver options from the matlab call to a solver object
- void **setModelData** (const mxArray ∗prhs[ ], int nrhs, Model &model)

  setModelData sets data from the matlab call to the model object
- void mexFunction (int nlhs, mxArray ∗plhs[ ], int nrhs, const mxArray ∗prhs[ ])

10.19.1 Detailed Description

This file defines the fuction mexFunction which is executed upon calling the mex file from matlab

10.19.2 Macro Definition Documentation

10.19.2.1 _USE_MATH_DEFINES

```
#define _USE_MATH_DEFINES
```

MS definition of PI and other constants

Definition at line 22 of file interface_matlab.cpp.

10.19.2.2 M_PI

```
#define M_PI 3.14159265358979323846
```

define PI if we still have no definition

Definition at line 26 of file interface_matlab.cpp.

10.19.3 Function Documentation

10.19.3.1 dbl2int()

```
int dbl2int (
            const double x )
```

conversion from double to int with checking for loss of data

Parameters

x	input

Returns

int_x casted value

Definition at line 293 of file interface_matlab.cpp.

Here is the call graph for this function:

Here is the caller graph for this function:

10.19.3.2 amici_blasCBlasTransToBlasTrans()

```
char amici::amici_blasCBlasTransToBlasTrans (
            AMICI_BLAS_TRANSPOSE trans )
```

amici_blasCBlasTransToBlasTrans translates AMICI_BLAS_TRANSPOSE values to CBlas readable strings

Parameters

trans	flag indicating transposition and complex conjugation

Returns

cblastrans CBlas readable CHAR indicating transposition and complex conjugation

Definition at line 60 of file interface_matlab.cpp.

Here is the call graph for this function:

Here is the caller graph for this function:

10.19.3.3 amici_dgemm()

```
void amici_dgemm (
            AMICI_BLAS_LAYOUT layout,
            AMICI_BLAS_TRANSPOSE TransA,
            AMICI_BLAS_TRANSPOSE TransB,
            const int M,
            const int N,
            const int K,
            const double alpha,
            const double * A,
            const int lda,
            const double * B,
            const int ldb,
            const double beta,
            double * C,
            const int ldc )
```

amici_dgemm provides an interface to the blas matrix matrix multiplication routine dgemm. This routines computes C = alpha∗A∗B + beta∗C with A: [MxK] B:[KxN] C:[MxN]

Parameters

in	*layout*	can be AMICI_BLAS_ColMajor or AMICI_BLAS_RowMajor.

Parameters

in	*TransA*	flag indicating whether A should be transposed before multiplication
in	*TransB*	flag indicating whether B should be transposed before multiplication
in	*M*	number of rows in A/C
in	*N*	number of columns in B/C
in	*K*	number of rows in B, number of columns in A
in	*alpha*	coefficient alpha
in	*A*	matrix A
in	*lda*	leading dimension of A (m or k)
in	*B*	matrix B
in	*ldb*	leading dimension of B (k or n)
in	*beta*	coefficient beta
in,out	*C*	matrix C
in	*ldc*	leading dimension of C (m or n)

amici_dgemm provides an interface to the CBlas matrix matrix multiplication routine dgemm. This routines computes C = alpha∗A∗B + beta∗C with A: [MxK] B:[KxN] C:[MxN]

Parameters

	layout	memory layout.
	TransA	flag indicating whether A should be transposed before multiplication
	TransB	flag indicating whether B should be transposed before multiplication
	M	number of rows in A/C
	N	number of columns in B/C
	K	number of rows in B, number of columns in A
	alpha	coefficient alpha
	A	matrix A
	lda	leading dimension of A (m or k)
	B	matrix B
	ldb	leading dimension of B (k or n)
	beta	coefficient beta
in,out	*C*	matrix C
	ldc	leading dimension of C (m or n)

Returns

void

Definition at line 44 of file cblas.cpp.

10.19.3.4 amici_dgemv()

```
void amici_dgemv (
            AMICI_BLAS_LAYOUT layout,
            AMICI_BLAS_TRANSPOSE TransA,
            const int M,
```

```
const int N,
const double alpha,
const double * A,
const int lda,
const double * X,
const int incX,
const double beta,
double * Y,
const int incY )
```

amici_dgemm provides an interface to the blas matrix vector multiplication routine dgemv. This routines computes y = alpha∗A∗x + beta∗y with A: [MxK] B:[KxN] C:[MxN]

Parameters

in	*layout*	can be AMICI_BLAS_ColMajor or AMICI_BLAS_RowMajor.
in	*TransA*	flag indicating whether A should be transposed before multiplication
in	*M*	number of rows in A
in	*N*	number of columns in A
in	*alpha*	coefficient alpha
in	*A*	matrix A
in	*lda*	leading dimension of A (m or n)
in	*X*	vector X
in	*incX*	increment for entries of X
in	*beta*	coefficient beta
in,out	*Y*	vector Y
in	*incY*	increment for entries of Y

amici_dgemm provides an interface to the CBlas matrix vector multiplication routine dgemv. This routines computes y = alpha∗A∗x + beta∗y with A: [MxN] x:[Nx1] y:[Mx1]

Parameters

	layout	always needs to be AMICI_BLAS_ColMajor.
	TransA	flag indicating whether A should be transposed before multiplication
	M	number of rows in A
	N	number of columns in A
	alpha	coefficient alpha
	A	matrix A
	lda	leading dimension of A (m or n)
	X	vector X
	incX	increment for entries of X
	beta	coefficient beta
in,out	*Y*	vector Y
	incY	increment for entries of Y

Returns

void

Definition at line 73 of file cblas.cpp.

10.19.3.5 expDataFromMatlabCall()

```
ExpData * expDataFromMatlabCall (
            const mxArray * prhs[],
            const Model & model )
```

expDataFromMatlabCall initialises the experimental data struct

Parameters

in	*prhs*	user input **Type**: ∗mxArray

Returns

edata: experimental data struct
Type: ∗ExpData

expDataFromMatlabCall parses the experimental data from the matlab call and writes it to an ExpData class object

Parameters

prhs	pointer to the array of input arguments
model	pointer to the model object, this is necessary to perform dimension checks

Returns

edata pointer to experimental data object

Definition at line 168 of file interface_matlab.cpp.

10.19.3.6 setSolverOptions()

```
void setSolverOptions (
            const mxArray * prhs[],
            int nrhs,
            Solver & solver )
```

Parameters

in	*prhs*	pointer to the array of input arguments **Type**: mxArray
in	*nrhs*	number of elements in prhs
in,out	*solver*	solver to update

Definition at line 299 of file interface_matlab.cpp.

10.19.3.7 setModelData()

```
void setModelData (
            const mxArray * prhs[],
            int nrhs,
            Model & model )
```

Parameters

in	*prhs*	pointer to the array of input arguments **Type**: mxArray
in	*nrhs*	number of elements in prhs
in,out	*model*	model to update

Definition at line 380 of file interface_matlab.cpp.

10.19.3.8 mexFunction()

```
void mexFunction (
            int nlhs,
            mxArray * plhs[],
            int nrhs,
            const mxArray * prhs[] )
```

mexFunction is the main interface function for the MATLAB interface. It reads in input data (udata and edata) and creates output data compound (rdata) and then calls the AMICI simulation routine to carry out numerical integration.

Parameters

nlhs	number of output arguments of the matlab call
plhs	pointer to the array of output arguments
nrhs	number of input arguments of the matlab call
prhs	pointer to the array of input arguments

Returns

void

Definition at line 524 of file interface_matlab.cpp.

10.20 src/spline.cpp File Reference

definition of spline functions

Functions

- int **spline** (int n, int end1, int end2, double slope1, double slope2, double x[ ], double y[ ], double b[ ], double c[ ], double d[ ])
- double **seval** (int n, double u, double x[ ], double y[ ], double b[ ], double c[ ], double d[ ])
- double **sinteg** (int n, double u, double x[ ], double y[ ], double b[ ], double c[ ], double d[ ])

10.20.1 Detailed Description

Author

Peter & Nigel, Design Software, 42 Gubberley St, Kenmore, 4069, Australia.

10.20.2 Function Documentation

10.20.2.1 spline()

```
int spline (
            int n,
            int end1,
            int end2,
            double slope1,
            double slope2,
            double x[],
            double y[],
            double b[],
            double c[],
            double d[] )
```

Evaluate the coefficients b[i], c[i], d[i], i = 0, 1, .. n-1 for a cubic interpolating spline

S(xx) = Y[i] + b[i] ∗ w + c[i] ∗ w∗∗2 + d[i] ∗ w∗∗3 where w = xx - x[i] and x[i] <= xx <= x[i+1]

The n supplied data points are x[i], y[i], i = 0 ... n-1.

Parameters

in	*n*	The number of data points or knots (n >= 2)
in	*end1*	0: default condition 1: specify the slopes at x[0]
in	*end2*	0: default condition 1: specify the slopes at x[n-1]
in	*slope1*	slope at x[0]
in	*slope2*	slope at x[n-1]
in	*x[]*	the abscissas of the knots in strictly increasing order
in	*y[]*	the ordinates of the knots
out	*b[]*	array of spline coefficients
out	*c[]*	array of spline coefficients
out	*d[]*	array of spline coefficients

Return values

0	normal return
1	less than two data points; cannot interpolate
2	x[] are not in ascending order

Notes

- The accompanying function seval() may be used to evaluate the spline while deriv will provide the first derivative.
- Using p to denote differentiation y[i] = S(X[i]) b[i] = Sp(X[i]) c[i] = Spp(X[i])/2 d[i] = Sppp(X[i])/6 (Derivative from the right)
- Since the zero elements of the arrays ARE NOW used here, all arrays to be passed from the main program should be dimensioned at least [n]. These routines will use elements [0 .. n-1].
- Adapted from the text Forsythe, G.E., Malcolm, M.A. and Moler, C.B. (1977) "Computer Methods for Mathematical Computations" Prentice Hall
- Note that although there are only n-1 polynomial segments, n elements are requird in b, c, d. The elements b[n-1], c[n-1] and d[n-1] are set to continue the last segment past x[n-1].

Definition at line 63 of file spline.cpp.

10.20.2.2 seval()

```
double seval (
            int n,
            double u,
            double x[],
            double y[],
            double b[],
            double c[],
            double d[] )
```

Evaluate the cubic spline function

S(xx) = y[i] + b[i] ∗ w + c[i] ∗ w∗∗2 + d[i] ∗ w∗∗3 where w = u - x[i] and x[i] <= u <= x[i+1] Note that Horner's rule is used. If u < x[0] then i = 0 is used. If u > x[n-1] then i = n-1 is used.

Parameters

in	*n*	The number of data points or knots (n >= 2)
in	*u*	the abscissa at which the spline is to be evaluated
in	*x[]*	the abscissas of the knots in strictly increasing order
in	*y[]*	the ordinates of the knots
in	*b*	array of spline coefficients computed by spline().
in	*c*	array of spline coefficients computed by spline().
in	*d*	array of spline coefficients computed by spline().

Returns

the value of the spline function at u

Notes

- If u is not in the same interval as the previous call then a binary search is performed to determine the proper interval.

Definition at line 195 of file spline.cpp.

10.20.2.3 sinteg()

```
double sinteg (
            int n,
            double u,
            double x[],
            double y[],
            double b[],
            double c[],
            double d[] )
```

Integrate the cubic spline function

S(xx) = y[i] + b[i] ∗ w + c[i] ∗ w∗∗2 + d[i] ∗ w∗∗3 where w = u - x[i] and x[i] <= u <= x[i+1]

The integral is zero at u = x[0].

If u < x[0] then i = 0 segment is extrapolated. If u > x[n-1] then i = n-1 segment is extrapolated.

Parameters

in	*n*	the number of data points or knots (n >= 2)
in	*u*	the abscissa at which the spline is to be evaluated
in	*x[]*	the abscissas of the knots in strictly increasing order
in	*y[]*	the ordinates of the knots
in	*b*	array of spline coefficients computed by spline().
in	*c*	array of spline coefficients computed by spline().
in	*d*	array of spline coefficients computed by spline().

Returns

the value of the spline function at u

Notes

- If u is not in the same interval as the previous call then a binary search is performed to determine the proper interval.

Definition at line 256 of file spline.cpp.

10.21 src/symbolic_functions.cpp File Reference

definition of symbolic functions

```
#include "amici/symbolic_functions.h"
#include "amici/spline.h"
#include <algorithm>
```

```
#include <cfloat>
#include <cmath>
#include <cstdarg>
#include <cstdlib>
#include <alloca.h>
```

Include dependency graph for symbolic_functions.cpp:

Functions

- int **isNaN** (double what)
- int **isInf** (double what)
- double **getNaN** ()
- double **log** (double x)
- double **dirac** (double x)
- double **heaviside** (double x)
- double **sign** (double x)
- double **max** (double a, double b, double c)
- double **min** (double a, double b, double c)
- double **Dmax** (int id, double a, double b, double c)
- double **Dmin** (int id, double a, double b, double c)
- double **spline** (double t, int num,...)
- double **spline_pos** (double t, int num,...)
- double **Dspline** (int id, double t, int num,...)
- double **Dspline_pos** (int id, double t, int num,...)
- double **DDspline** (int id1, int id2, double t, int num,...)
- double **DDspline_pos** (int id1, int id2, double t, int num,...)

10.21.1 Detailed Description

This file contains definitions of various symbolic functions which

10.21.2 Function Documentation

10.21.2.1 isNaN()

```
int isNaN (
            double what )
```

c++ interface to the isNaN function

Parameters

what	argument

Returns

isnan(what)

Definition at line 35 of file symbolic_functions.cpp.

10.21.2.2 isInf()

```
int isInf (
            double what )
```

c++ interface to the isinf function

Parameters

what	argument

Returns

isnan(what)

Definition at line 44 of file symbolic_functions.cpp.

10.21.2.3 getNaN()

```
double getNaN ( )
```

function returning nan

Returns

NaN

Definition at line 52 of file symbolic_functions.cpp.

10.21.2.4 log()

```
double log (
            double x )
```

c implementation of log function, this prevents returning NaN values for negative values

Parameters

x	argument

Returns

if(x>0) then log(x) else -Inf

Definition at line 62 of file symbolic_functions.cpp.

10.21.2.5 dirac()

```
double dirac (
            double x )
```

c implementation of matlab function dirac

Parameters

x	argument

Returns

if(x==0) then INF else 0

Definition at line 77 of file symbolic_functions.cpp.

10.21.2.6 heaviside()

```
double heaviside (
            double x )
```

c implementation of matlab function heaviside

Parameters

x	argument

Returns

if(x>0) then 1 else 0

Definition at line 92 of file symbolic_functions.cpp.

10.21.2.7 sign()

```
double sign (
            double x )
```

c implementation of matlab function sign

Parameters

x	argument

Returns

0

Definition at line 107 of file symbolic_functions.cpp.

10.21.2.8 max()

```
double max (
            double a,
            double b,
            double c )
```

c implementation of matlab function max

Parameters

a	value1
b	value2
c	bogus parameter to ensure correct parsing as a function

Returns

if(a > b) then a else b

Definition at line 128 of file symbolic_functions.cpp.

10.21.2.9 min()

```
double min (
            double a,
            double b,
            double c )
```

c implementation of matlab function min

Parameters

a	value1
b	value2
c	bogus parameter to ensure correct parsing as a function

Returns

if(a < b) then a else b

Definition at line 149 of file symbolic_functions.cpp.

10.21.2.10 Dmax()

```
double Dmax (
            int id,
            double a,
            double b,
            double c )
```

parameter derivative of c implementation of matlab function max

Parameters

id	argument index for differentiation
a	value1
b	value2
c	bogus parameter to ensure correct parsing as a function

Returns

id == 1: if(a > b) then 1 else 0
id == 2: if(a > b) then 0 else 1

Definition at line 164 of file symbolic_functions.cpp.

10.21.2.11 Dmin()

```
double Dmin (
            int id,
            double a,
            double b,
            double c )
```

parameter derivative of c implementation of matlab function max

Parameters

id	argument index for differentiation
a	value1
b	value2
c	bogus parameter to ensure correct parsing as a function

Returns

id == 1: if(a > b) then 1 else 0
id == 2: if(a > b) then 0 else 1

Definition at line 191 of file symbolic_functions.cpp.

10.21.2.12 spline()

```
double spline (
            double t,
            int num,
             ...  )
```

spline function, takes variable argument pairs (ti,pi) with `ti`: location of node i and `pi`: spline value at node i. the last two arguments are always `ss`: flag indicating whether slope at first node should be user defined and `dudt` user defined slope at first node. All arguments must be of type double.

Parameters

t	point at which the spline should be evaluated
num	number of spline nodes

Returns

spline(t)

Definition at line 209 of file symbolic_functions.cpp.

10.21.2.13 spline_pos()

```
double spline_pos (
            double t,
            int num,
             ...  )
```

exponentiated spline function, takes variable argument pairs (ti,pi) with `ti`: location of node i and `pi`: spline value at node i. the last two arguments are always `ss`: flag indicating whether slope at first node should be user defined and `dudt` user defined slope at first node. All arguments must be of type double.

Parameters

t	point at which the spline should be evaluated
num	number of spline nodes

Returns

spline(t)

Definition at line 263 of file symbolic_functions.cpp.

10.21.2.14 Dspline()

```
double Dspline (
            int id,
            double t,
            int num,
             ...  )
```

derivation of a spline function, takes variable argument pairs (ti,pi) with `ti`: location of node i and `pi`: spline value at node i. the last two arguments are always `ss`: flag indicating whether slope at first node should be user defined and `dudt` user defined slope at first node. All arguments but id must be of type double.

Parameters

id	index of node to which the derivative of the corresponding spline coefficient should be computed
t	point at which the spline should be evaluated
num	number of spline nodes

Returns

dsplinedp(t)

Definition at line 319 of file symbolic_functions.cpp.

10.21.2.15 Dspline_pos()

```
double Dspline_pos (
            int id,
            double t,
            int num,
             ...  )
```

derivation of an exponentiated spline function, takes variable argument pairs (ti,pi) with `ti`: location of node i and `pi`: spline value at node i. the last two arguments are always `ss`: flag indicating whether slope at first node should be user defined and `dudt` user defined slope at first node. All arguments but id must be of type double.

Parameters

id	index of node to which the derivative of the corresponding spline coefficient should be computed
t	point at which the spline should be evaluated
num	number of spline nodes

Returns

dsplinedp(t)

Definition at line 379 of file symbolic_functions.cpp.

10.21.2.16 DDspline()

```
double DDspline (
            int id1,
            int id2,
            double t,
            int num,
             ...  )
```

second derivation of a spline function, takes variable argument pairs (ti,pi) with `ti`: location of node i and `pi`: spline value at node i. the last two arguments are always `ss`: flag indicating whether slope at first node should be user defined and `dudt` user defined slope at first node. All arguments but id1 and id2 must be of type double.

Parameters

id1	index of node to which the first derivative of the corresponding spline coefficient should be computed
id2	index of node to which the second derivative of the corresponding spline coefficient should be computed
t	point at which the spline should be evaluated
num	number of spline nodes

Returns

ddspline(t)

Definition at line 449 of file symbolic_functions.cpp.

10.21.2.17 DDspline_pos()

```
double DDspline_pos (
            int id1,
            int id2,
            double t,
            int num,
             ...  )
```

derivation of an exponentiated spline function, takes variable argument pairs (ti,pi) with `ti`: location of node i and `pi`: spline value at node i. the last two arguments are always `ss`: flag indicating whether slope at first node should be user defined and `dudt` user defined slope at first node. All arguments but id1 and id2 must be of type double.

Parameters

id1	index of node to which the first derivative of the corresponding spline coefficient should be computed
id2	index of node to which the second derivative of the corresponding spline coefficient should be computed
t	point at which the spline should be evaluated
num	number of spline nodes

Returns

ddspline(t)

Definition at line 469 of file symbolic_functions.cpp.

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