AMICI

Generated by Doxygen 1.8.14

Contents

1 About AMICI 1

2 License Conditions 2

3 How to contribute 2

4 Installation 3

5 Python Interface 5

6 MATLAB Interface 6

7 C++ Interface 12

8 FAQ 13

9 Data Structure Documentation 14

9.1 AmiException Class Reference 14

9.2 AmiVector Class Reference 16

9.3 AmiVectorArray Class Reference 24

9.4 BackwardProblem Class Reference 31

9.5 CvodeException Class Reference 37

9.6 ExpData Class Reference 38

9.7 ForwardProblem Class Reference 43

9.8 IDAException Class Reference 53

9.9 IntegrationFailure Class Reference 54

9.10 Model Class Reference 56

9.11 Model_DAE Class Reference 156

9.12 Model_ODE Class Reference 184

9.13 NewtonFailure Class Reference 212

9.14 NewtonSolver Class Reference 213

9.15 NewtonSolverDense Class Reference 220

9.16 NewtonSolverIterative Class Reference 223

9.17 NewtonSolverSparse Class Reference . . . 227

9.18 ReturnData Class Reference . . . 229

9.19 SBMLException Class Reference . . . 244

9.20 SbmlImporter Class Reference . . . 245

9.21 TemplateAmici Class Reference . . . 272

9.22 SetupFailure Class Reference . . . 273

9.23 Solver Class Reference . . . 275

9.24 SteadystateProblem Class Reference . . . 335

9.25 amidata Class Reference . . . 339

9.26 amievent Class Reference . . . 344

9.27 amifun Class Reference . . . 347

9.28 amimodel Class Reference . . . 354

9.29 amioption Class Reference . . . 378

9.30 amised Class Reference . . . 386

9.31 optsym Class Reference . . . 389

Index **391**

1 About AMICI

AMICI provides a multilanguage (Python, C++, Matlab) interface for the SUNDIALS solvers CVODES (for ordinary differential equations) and IDAS (for algebraic differential equations). AMICI allows the user to read differential equation models specified as SBML and automatically compiles such models as .mex simulation fiels, C++ executables or python modules. In contrast to the SUNDIALSTB interface, all necessary functions are transformed into native C++ code, which allows for a significantly faster simulation. Beyond forward integration, the compiled simulation file also allows for 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.

Current build status

Linux/Mac: `![TravisCI][TravisBade]`

Coverage: `![Coverage Status]`

2 License Conditions

Copyright (c) 2015-2018, Fabian Fröhlich, Jan Hasenauer, Daniel Weindl and Paul Stapor All rights reserved.

Redistribution and use in source and binary forms, with or without modification, are permitted provided that the following conditions are met:

1. Redistributions of source code must retain the above copyright notice, this list of conditions and the following disclaimer.
2. Redistributions in binary form must reproduce the above copyright notice, this list of conditions and the following disclaimer in the documentation and/or other materials provided with the distribution.
3. Neither the name of the copyright holder nor the names of its contributors may be used to endorse or promote products derived from this software without specific prior written permission.

THIS SOFTWARE IS PROVIDED BY THE COPYRIGHT HOLDERS AND CONTRIBUTORS "AS IS" AND ANY EXPRESS OR IMPLIED WARRANTIES, INCLUDING, BUT NOT LIMITED TO, THE IMPLIED WARRANTIES OF MERCHANTABILITY AND FITNESS FOR A PARTICULAR PURPOSE ARE DISCLAIMED. IN NO EVENT SHALL THE COPYRIGHT HOLDER OR CONTRIBUTORS BE LIABLE FOR ANY DIRECT, INDIRECT, INCIDENTAL, SPECIAL, EXEMPLARY, OR CONSEQUENTIAL DAMAGES (INCLUDING, BUT NOT LIMITED TO, PROCUREMENT OF SUBSTITUTE GOODS OR SERVICES; LOSS OF USE, DATA, OR PROFITS; OR BUSINESS INTERRUPTION) HOWEVER CAUSED AND ON ANY THEORY OF LIABILITY, WHETHER IN CONTRACT, STRICT LIABILITY, OR TORT (INCLUDING NEGLIGENCE OR OTHERWISE) ARISING IN ANY WAY OUT OF THE USE OF THIS SOFTWARE, EVEN IF ADVISED OF THE POSSIBILITY OF SUCH DAMAGE.

3 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]

4 Installation

Availability

The sources for AMICI are accessible as

- Source `tarball`
- Source `zip`
- GIT repository on `github`

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/ICB-DCM/AMICI` and a direct clone is possible via

```
git clone https://github.com/ICB-DCM/AMICI.git AMICI
```

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.

MATLAB

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

```
installAMICI.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.com`

Python

To use AMICI from Python, run the

```
./scripts/buildSundials.sh
./scripts/buildSuitesparse.sh
./scripts/buildAmici.sh
```

scripts to compile amici and generate the python module. After successful execution of the script, amici is available as system wide module and can be imported via

```
import amici
```

C++

To use AMICI from C++, run the

```
./scripts/buildSundials.sh
./scripts/buildSuitesparse.sh
./scripts/buildAmici.sh
```

script to compile amici libary. The static library file can then be linked from

```
./build/libamici.a
```

Dependencies

The MATLAB interface requires the Mathworks Symbolic Toolbox for model generation via `amiwrap(...)`, but not for execution of precompiled models.

The Python and C++ interfaces require `cmake` and `cblas` to be installed.

The tools SUNDIALS and SuiteSparse shipped with AMICI do **not** require explicit 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

5 Python Interface

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

Model Definition

This guide will guide the user on how specify models in Python using SBML. For example implementations see the examples in the python/examples directory.

SBML input

First, import an sbml file using the `SbmlImporter` class:

```
import amici
sbmlImporter = amici.SbmlImporter('model_steadystate_scaled.sbml')
```

the sbml document as imported by `libSBML` is available as

```
sbml = sbmlImporter.sbml
```

Constants

parameters that should be considered constants can be specified in a list of strings specifying the respective SbmlId of a parameter.

```
constantParameters=['k4']
```

Observables

assignment rules that should be considered as observables can extracted using the `amici.assignmentRules2observables` function

```
observables = amici.assignmentRules2observables(sbml, filter=lambda variableId:
                                                variableId.startswith('observable_') and not variableId.endswi
```

Standard Deviations

standard deviations can be specified as dictionaries ...

```
sigmas = {'observable_x1withsigma': 'observable_x1withsigma_sigma'}
```

Model Compilation

to compile the sbml as python module, the user has to call the `SbmlImporter` method `sbml2amici`, passing all the previously defined model specifications

```
sbmlImporter.sbml2amici('test', 'test',
                        observables=observables,
                        constantParameters=constantParameters,
                        sigmas=sigma)
```

Model Simulation

currently the model folder has to be manually added to the python path

```
import os
import sys
sys.path.insert(0, 'test')
```

the compiled model can now be imported as python module

```
import test as modelModule
```

to obtain a model instance call the `getModel()` method. This model instance will be instantiated using the defautl parameter values specified in the sbml.

```
model = modelModule.getModel()
```

then pass the simulation timepoints as `amici.DoubleVector` to `model.setTimepoints`

```
model.setTimepoints(amici.DoubleVector(np.linspace(0, 60, 60)))
```

for simulation we need to generate a solver instance

```
solver = model.getSolver()
```

the model simulation can now be carried out using

```
rdata = amici.runAmiciSimulation(model, solver)
```

6 MATLAB Interface

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

Model Definition

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

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()
```

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	
.param	default 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 false, the fields 'forward' and 'adjoint' will speed up the time required to compile the model but also disable the respective sensitivity computation.

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:

```
model.sym.x = [ state1 state2 state3 ];
```

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

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

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

```
model.sym.k = [ const1 const2 ];
```

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`

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

or

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

The specification of `f` or `xdot` may depend on states, parameters and constants.

For DAEs also specify the mass matrix.

```
model.syms.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 `src/symbolic_functions.cpp`.

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.

Initial Conditions

Specify the initial conditions. These may depend on parameters on constants and must have the same size as `x`.

```
model.syms.x0 = [ param4, 0, 0 ];
```

Observables

Specify the observables. These may depend on parameters and constants.

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

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

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.

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

Events may depend on states, parameters and constants but **not** on observables

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

```
model.syms.sigma_y(1) = param5;
```

Standard deviaton for event data is denoted by sigma_t

```
model.syms.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 `D.Sigma_Y` or `D.Sigma_T` in the user-provided data struct is `NaN`. See simulation for details.

Objective Function

By default, AMICI assume a normal noise model and use the corresponding negative log-likelihood

```
J = 1/2*sum(((y_i(t)-my_ti)/sigma_y_i)^2 + log(2*pi*sigma_y^2)
```

as objective function.

SBML

AMICI can also import SBML models using the command `SBML2AMICI`. This will generate a model specification as described above, which may be edited by the user to apply further changes.

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 models and pass them directly to `amiwrap(...)` without generating respective model definition scripts.

Model Simulation

After the call to `amiwrap(...)` two files will be placed in the specified directory. One is a *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.

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 event outputs will then be available as `sol.z`. If no event occured there will be an event at the end of the considered interval with the final value of the root function is stored in `sol.rz`.

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 flag `status` . 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.

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.sensi_meth = 'forward;
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 event outputs will then be available as `sol.z`, with the derivative with respect to the parameters in `sol.sz`. 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.rz`, with the derivative with respect to the parameters in `sol.srz`.

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.

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.sensi_meth = 'adjoint';
```

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.

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.

Set the final timepoint as infinity, this will indicate the solver to compute the steadystate:

```
t = Inf;
```

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;
```

Integrate:

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

The states will be available as `sol.x`, with the derivative with respect to the parameters in `sol.sx`. The observables will 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.diagnosis.xdot`.

7 C++ Interface

The Python and Matlab interfaces can translate the model definition into C++ code, which is then compiled into a .mex file or a python module. Advanced users can also use this code within stand-alone C/C++ application for use in other 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
[... many more files model_steadystate_*.(cpp|h|md5|o) ]
wrapfunctions.cpp
wrapfunctions.h
model_steadystate.h
```

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 `runAmiciSimulation(...)`, declared in amici.h. This function requires (i) a `Model` instance. For the example `model_steadystate` the respective class is provided as `Model_model_steadystate` in `model_steadystate.h`. For convenience, the header `wrapfunctions.h` defines a function `getModel()`, that returns an instance of that class. (ii) a `Solver` instance. This solver instance needs to match the requirements of the model and can be generated using `model->getSolver()`. (iii) optionally an `ExpData` instance, which contains any experimental data.

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. `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`.

8 FAQ

Q: My model fails to build.

A: Remove the corresponding model directory located in AMICI/models/∗yourmodelname∗ and compile again.

Q: It still does not compile.

A: Make an `issue` and we will have a look.

Q: I get an out of memory error while compiling my model on a Windows machine.

A: This may be due to an old compiler version. See `issue #161` for instructions on how to install a new compiler.

Q: The simulation/sensitivities I get are incorrect.

A: There are some known issues, especially with adjoint sensitivities, events and DAEs. If your particular problem is not featured in the `issues` list, please add it!

9 Data Structure Documentation

9.1 AmiException Class Reference

amici exception handler class

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

Inheritance 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,
             ...  )  [inline]
```

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 ) [inline]
```

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 ) [inline]
```

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  [inline]
```

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 )  [inline]
```

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 ) [inline]
```

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 ) [inline]
```

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 )  [inline]
```

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 ( )  [inline]
```

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 )  [inline]
```

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 ( ) [inline]
```

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  [inline]
```

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  [inline]
```

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  [inline]
```

Vector accessor

Returns

Vector

Definition at line 84 of file vector.h.

9.2.3.6 getLength()

```
int getLength ( ) const  [inline]
```

returns the length of the vector

Returns

length

Definition at line 91 of file vector.h.

9.2.3.7 reset()

```
void reset ( )  [inline]
```

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 ( )  [inline]
```

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 )  [inline]
```

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 )  [inline]
```

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 )  [inline]
```

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 )  [inline]
```

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 )  [inline]
```

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 ( )  [inline]
```

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 )  [inline]
```

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  [inline]
```

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 )  [inline]
```

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 ( ) [inline]
```

accessor to NVectorArray

Returns

N_VectorArray

Definition at line 212 of file vector.h.

9.3.3.5 getNVector()

```
N_Vector getNVector (
            int pos ) [inline]
```

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 ) [inline]
```

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  [inline]
```

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  [inline]
```

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 ( ) [inline]
```

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  [inline]
```

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  [inline]
```

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 ( )  [inline]
```

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 ( ) [inline]
```

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 ( ) [inline]
```

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 ( ) [inline]
```

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 [inline]
```

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:

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 )  [inline]
```

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)

Data Fields

- 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	
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 Field 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>
```

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 ()

Data Fields

- 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 ( ) [inline]
```

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  [inline]
```

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  [inline]
```

accessor for sx

Returns

sx

Definition at line 52 of file forwardproblem.h.

9.7.3.4 getStatesAtDiscontinuities()

```
AmiVectorArray getStatesAtDiscontinuities ( ) const  [inline]
```

accessor for x_disc

Returns

x_disc

Definition at line 59 of file forwardproblem.h.

9.7.3.5 getRHSAtDiscontinuities()

```
AmiVectorArray getRHSAtDiscontinuities ( ) const  [inline]
```

accessor for xdot_disc

Returns

xdot_disc

Definition at line 66 of file forwardproblem.h.

9.7.3.6 getRHSBeforeDiscontinuities()

```
AmiVectorArray getRHSBeforeDiscontinuities ( ) const  [inline]
```

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  [inline]
```

accessor for nroots

Returns

nroots

Definition at line 80 of file forwardproblem.h.

9.7.3.8 getDiscontinuities()

```
std::vector<realtype> getDiscontinuities ( ) const  [inline]
```

accessor for discs

Returns

discs

Definition at line 87 of file forwardproblem.h.

9.7.3.9 getRootIndexes()

```
std::vector<int> getRootIndexes ( ) const  [inline]
```

accessor for rootidx

Returns

rootidx

Definition at line 94 of file forwardproblem.h.

9.7.3.10 getDJydx()

```
std::vector<realtype> getDJydx ( ) const  [inline]
```

accessor for dJydx

Returns

dJydx

Definition at line 101 of file forwardproblem.h.

9.7.3.11 getDJzdx()

```
std::vector<realtype> getDJzdx ( ) const  [inline]
```

accessor for dJzdx

Returns

dJzdx

Definition at line 108 of file forwardproblem.h.

9.7.3.12 getRootCounter()

```
int getRootCounter ( ) const  [inline]
```

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 ( )  [inline]
```

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 ( ) [inline]
```

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 ( ) [inline]
```

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 ( ) [inline]
```

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 Field 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:

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 )  [inline]
```

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:

Public Member Functions

- IntegrationFailure (int code, realtype t)

Data Fields

- 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 )  [inline]
```

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 Field 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:

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 ∗nroots, 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< 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.

Data Fields

- 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
- 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 ( ) [inline]
```

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 ) [inline]
```

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 )  [inline]
```

Copy constructor

Parameters

other	object to copy from

Returns

Definition at line 135 of file model.h.

9.10.2.4 ~Model()

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

default destructor

Definition at line 360 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.

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 320 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 )  [inline], [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 287 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 329 of file model.cpp.

Here is the call graph for this function:

9.10.3.14 fsdx0()

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

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

Definition at line 294 of file model.h.

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 341 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 352 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 360 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 371 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 383 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 395 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 409 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 421 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 432 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 444 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 454 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 466 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 478 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 492 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 509 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 523 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 536 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 556 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 569 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 588 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 599 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 616 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 634 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 651 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 668 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 684 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 701 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 717 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 734 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,
            const int ie,
            ReturnData * rdata )
```

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

Parameters

nroots	number of events for event index
ie	event index
rdata	pointer to return data instance

Definition at line 38 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 52 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 87 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 116 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 142 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 183 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 227 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 254 of file model.cpp.

Here is the call 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 267 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 284 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  [inline]
```

number of paramaeters wrt to which sensitivities are computed

Returns

length of sensitivity index vector

Definition at line 392 of file model.h.

Here is the caller graph for this function:

9.10.3.56 np()

```
int np ( ) const  [inline]
```

total number of model parameters

Returns

length of parameter vector

Definition at line 398 of file model.h.

Here is the caller graph for this function:

9.10.3.57 nk()

```
int nk ( ) const [inline]
```

number of constants

Returns

length of constant vector

Definition at line 404 of file model.h.

Here is the caller graph for this function:

9.10.3.58 k()

```
const double* k ( ) const  [inline]
```

constants

Returns

pointer to constants array

Definition at line 411 of file model.h.

Here is the caller graph for this function:

9.10.3.59 nMaxEvent()

```
int nMaxEvent ( ) const  [inline]
```

Returns

nmaxevent

Definition at line 419 of file model.h.

9.10.3.60 setNMaxEvent()

```
void setNMaxEvent (
            int nmaxevent )  [inline]
```

Parameters

nmaxevent	

Definition at line 427 of file model.h.

9.10.3.61 nt()

```
int nt ( ) const  [inline]
```

Returns

number of timepoints

Definition at line 435 of file model.h.

9.10.3.62 getParameterScale()

```
std::vector<AMICI_parameter_scaling> getParameterScale ( ) const  [inline]
```

Returns

Definition at line 443 of file model.h.

9.10.3.63 setParameterScale() [1/2]

```
void setParameterScale (
            AMICI_parameter_scaling pscale )  [inline]
```

Parameters

pscale	

Definition at line 451 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 )  [inline]
```

Parameters

pscale	

Definition at line 461 of file model.h.

Here is the call graph for this function:

9.10.3.65 getParameters()

```
std::vector<realtype> getParameters ( ) const  [inline]
```

Returns

The user-set parameters (see also getUnscaledParameters)

Definition at line 471 of file model.h.

9.10.3.66 setParameters()

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

Parameters

p	

Definition at line 479 of file model.h.

Here is the call graph for this function:

9.10.3.67 getUnscaledParameters()

```
std::vector<realtype> getUnscaledParameters ( ) const  [inline]
```

Returns

The unscaled parameters

Definition at line 491 of file model.h.

9.10.3.68 getFixedParameters()

```
std::vector<realtype> getFixedParameters ( ) const  [inline]
```

Returns

Definition at line 499 of file model.h.

Here is the caller graph for this function:

9.10.3.69 setFixedParameters()

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

Parameters

k	

Definition at line 507 of file model.h.

Here is the call graph for this function:

Here is the caller graph for this function:

9.10.3.70 getTimepoints()

```
std::vector<realtype> getTimepoints ( ) const  [inline]
```

Returns

Definition at line 517 of file model.h.

9.10.3.71 setTimepoints()

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

Parameters

ts	

Definition at line 525 of file model.h.

9.10.3.72 t()

```
double t (
            int idx ) const  [inline]
```

Parameters

idx	

Returns

Definition at line 534 of file model.h.

Here is the caller graph for this function:

9.10.3.73 getParameterList()

```
std::vector<int> getParameterList ( ) const  [inline]
```

Returns

Definition at line 542 of file model.h.

9.10.3.74 setParameterList()

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

Parameters

plist	

Definition at line 550 of file model.h.

Here is the call graph for this function:

9.10.3.75 getInitialStates()

```
std::vector<realtype> getInitialStates ( ) const  [inline]
```

Returns

Definition at line 563 of file model.h.

9.10.3.76 setInitialStates()

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

Parameters

x0	

Definition at line 571 of file model.h.

9.10.3.77 getInitialStateSensitivities()

```
std::vector<realtype> getInitialStateSensitivities ( ) const  [inline]
```

Returns

Definition at line 581 of file model.h.

9.10.3.78 setInitialStateSensitivities()

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

Parameters

sx0	

Definition at line 589 of file model.h.

Here is the call graph for this function:

9.10.3.79 t0()

```
double t0 ( ) const  [inline]
```

initial timepoint

Returns

timepoint

Definition at line 598 of file model.h.

Here is the caller graph for this function:

9.10.3.80 setT0()

```
void setT0 (
            double t0 )  [inline]
```

Parameters

t0	

Definition at line 606 of file model.h.

Here is the call graph for this function:

9.10.3.81 plist()

```
int plist (
            int pos ) const  [inline]
```

entry in parameter list

Parameters

pos	index

Returns

entry

Definition at line 614 of file model.h.

Here is the caller graph for this function:

9.10.3.82 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 897 of file model.cpp.

Here is the call graph for this function:

Here is the caller graph for this function:

9.10.3.83 fw() [1/2]

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

Parameters

t	timepoint
x	Vector with the states

Definition at line 749 of file model.cpp.

Here is the call graph for this function:

Here is the caller graph for this function:

9.10.3.84 fdwdp() [1/2]

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

Parameters

t	timepoint
x	Vector with the states

Definition at line 759 of file model.cpp.

Here is the call graph for this function:

Here is the caller graph for this function:

9.10.3.85 fdwdx() [1/2]

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

Parameters

t	timepoint
x	Vector with the states

Definition at line 770 of file model.cpp.

Here is the call graph for this function:

Here is the caller graph for this function:

9.10.3.86 updateHeaviside()

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

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 708 of file model.h.

9.10.3.87 updateHeavisideB()

```
void updateHeavisideB (
            const int * rootsfound )  [inline]
```

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 722 of file model.h.

9.10.3.88 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 825 of file model.cpp.

9.10.3.89 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 883 of file model.cpp.

Here is the caller graph for this function:

9.10.3.90 fx0() [2/2]

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

model specific implementation of fx0

Parameters

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

Definition at line 765 of file model.h.

9.10.3.91 fsx0() [2/2]

```
virtual void fsx0 (
            realtype * sx0,
            const realtype t,
            const realtype * x0,
            const realtype * p,
            const realtype * k,
            const int ip )  [inline], [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 777 of file model.h.

9.10.3.92 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 )  [inline], [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 792 of file model.h.

9.10.3.93 fy() [2/2]

```
virtual void fy (
            realtype * y,
            const realtype t,
            const realtype * x,
            const realtype * p,
            const realtype * k,
            const realtype * h )  [inline], [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 804 of file model.h.

9.10.3.94 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 )  [inline], [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 817 of file model.h.

9.10.3.95 fdydx() [2/2]

```
virtual void fdydx (
            realtype * dydx,
            const realtype t,
            const realtype * x,
            const realtype * p,
            const realtype * k,
            const realtype * h )  [inline], [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 829 of file model.h.

9.10.3.96 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 )  [inline], [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 842 of file model.h.

9.10.3.97 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 )  [inline], [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 857 of file model.h.

9.10.3.98 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 )  [inline], [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 870 of file model.h.

9.10.3.99 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 )  [inline], [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 885 of file model.h.

9.10.3.100 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 )  [inline], [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 899 of file model.h.

9.10.3.101 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 )  [inline], [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 912 of file model.h.

9.10.3.102 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 )  [inline], [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 926 of file model.h.

9.10.3.103 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 )  [inline], [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 939 of file model.h.

9.10.3.104 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 )  [inline], [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 954 of file model.h.

9.10.3.105 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 )  [inline], [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 974 of file model.h.

9.10.3.106 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 )  [inline], [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 992 of file model.h.

9.10.3.107 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 )  [inline], [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 1010 of file model.h.

9.10.3.108 fsigma_y() [2/2]

```
virtual void fsigma_y (
            realtype * sigmay,
            const realtype t,
            const realtype * p,
            const realtype * k )  [inline], [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 1021 of file model.h.

9.10.3.109 fdsigma_ydp() [2/2]

```
virtual void fdsigma_ydp (
            realtype * dsigmaydp,
            const realtype t,
            const realtype * p,
            const realtype * k,
            const int ip )  [inline], [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 1032 of file model.h.

9.10.3.110 fsigma_z() [2/2]

```
virtual void fsigma_z (
            realtype * sigmaz,
            const realtype t,
            const realtype * p,
            const realtype * k )  [inline], [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 1042 of file model.h.

9.10.3.111 fdsigma_zdp() [2/2]

```
virtual void fdsigma_zdp (
            realtype * dsigmazdp,
            const realtype t,
            const realtype * p,
            const realtype * k,
            const int ip )  [inline], [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 1053 of file model.h.

9.10.3.112 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 )  [inline], [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 1066 of file model.h.

9.10.3.113 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 )  [inline], [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 1078 of file model.h.

9.10.3.114 fJrz() [2/2]

```
virtual void fJrz (
            realtype * nllh,
            const int iz,
            const realtype * p,
            const realtype * k,
            const realtype * z,
            const realtype * sigmaz )  [inline], [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 1090 of file model.h.

9.10.3.115 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 )  [inline], [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 1103 of file model.h.

9.10.3.116 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 )  [inline], [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 1118 of file model.h.

9.10.3.117 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 )  [inline], [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 1132 of file model.h.

9.10.3.118 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 )  [inline], [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 1147 of file model.h.

9.10.3.119 fdJrzdz() [2/2]

```
virtual void fdJrzdz (
            realtype * dJrzdz,
            const int iz,
            const realtype * p,
            const realtype * k,
            const realtype * rz,
            const realtype * sigmaz )  [inline], [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 1160 of file model.h.

9.10.3.120 fdJrzdsigma() [2/2]

```
virtual void fdJrzdsigma (
            realtype * dJrzdsigma,
            const int iz,
            const realtype * p,
            const realtype * k,
            const realtype * rz,
            const realtype * sigmaz )  [inline], [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 1174 of file model.h.

9.10.3.121 fw() [2/2]

```
virtual void fw (
            realtype * w,
            const realtype t,
            const realtype * x,
            const realtype * p,
            const realtype * k,
            const realtype * h )  [inline], [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 1187 of file model.h.

9.10.3.122 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 )  [inline], [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 1199 of file model.h.

9.10.3.123 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 )  [inline], [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 1211 of file model.h.

9.10.3.124 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 780 of file model.cpp.

Here is the caller graph for this function:

9.10.3.125 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 833 of file model.cpp.

Here is the caller graph for this function:

9.10.3.126 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 815 of file model.cpp.

Here is the caller graph for this function:

9.10.3.127 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 797 of file model.cpp.

Here is the caller graph for this function:

9.10.3.128 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 806 of file model.cpp.

Here is the call graph for this function:

Here is the caller graph for this function:

9.10.3.129 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 850 of file model.cpp.

Here is the caller graph for this function:

9.10.3.130 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 859 of file model.cpp.

Here is the caller graph for this function:

9.10.3.131 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 869 of file model.cpp.

Here is the call graph for this function:

9.10.3.132 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 879 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 923 of file model.cpp.

9.10.5 Field Documentation

9.10.5.1 nx

```
const int nx
```

number of states

Definition at line 635 of file model.h.

9.10.5.2 nxtrue

```
const int nxtrue
```

number of states in the unaugmented system

Definition at line 637 of file model.h.

9.10.5.3 ny

```
const int ny
```

number of observables

Definition at line 639 of file model.h.

9.10.5.4 nytrue

```
const int nytrue
```

number of observables in the unaugmented system

Definition at line 641 of file model.h.

9.10.5.5 nz

```
const int nz
```

number of event outputs

Definition at line 643 of file model.h.

9.10.5.6 nztrue

```
const int nztrue
```

number of event outputs in the unaugmented system

Definition at line 645 of file model.h.

9.10.5.7 ne

```
const int ne
```

number of events

Definition at line 647 of file model.h.

9.10.5.8 nw

```
const int nw
```

number of common expressions

Definition at line 649 of file model.h.

9.10.5.9 ndwdx

```
const int ndwdx
```

number of derivatives of common expressions wrt x

Definition at line 651 of file model.h.

9.10.5.10 ndwdp

```
const int ndwdp
```

number of derivatives of common expressions wrt p

Definition at line 653 of file model.h.

9.10.5.11 nnz

```
const int nnz
```

number of nonzero entries in jacobian

Definition at line 655 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 657 of file model.h.

9.10.5.13 ubw

```
const int ubw
```

upper bandwith of the jacobian

Definition at line 659 of file model.h.

9.10.5.14 lbw

```
const int lbw
```

lower bandwith of the jacobian

Definition at line 661 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 664 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 666 of file model.h.

9.10.5.17 idlist

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

flag array for DAE equations

Definition at line 668 of file model.h.

9.10.5.18 sigmay

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

data standard deviation

Definition at line 671 of file model.h.

9.10.5.19 dsigmaydp

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

parameter derivative of data standard deviation

Definition at line 673 of file model.h.

9.10.5.20 sigmaz

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

event standard deviation

Definition at line 675 of file model.h.

9.10.5.21 dsigmazdp

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

parameter derivative of event standard deviation

Definition at line 677 of file model.h.

9.10.5.22 dJydp

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

parameter derivative of data likelihood

Definition at line 679 of file model.h.

9.10.5.23 dJzdp

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

parameter derivative of event likelihood

Definition at line 681 of file model.h.

9.10.5.24 deltax

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

change in x

Definition at line 684 of file model.h.

9.10.5.25 deltasx

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

change in sx

Definition at line 686 of file model.h.

9.10.5.26 deltaxB

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

change in xB

Definition at line 688 of file model.h.

9.10.5.27 deltaqB

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

change in qB

Definition at line 690 of file model.h.

9.10.5.28 dxdotdp

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

tempory storage of dxdotdp data across functions

Definition at line 693 of file model.h.

9.10.5.29 J

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

Jacobian

Definition at line 1233 of file model.h.

9.10.5.30 my

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

current observable

Definition at line 1236 of file model.h.

9.10.5.31 mz

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

current event measurement

Definition at line 1238 of file model.h.

9.10.5.32 dJydy

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

observable derivative of data likelihood

Definition at line 1240 of file model.h.

9.10.5.33 dJydsigma

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

observable sigma derivative of data likelihood

Definition at line 1242 of file model.h.

9.10.5.34 dJzdz

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

event ouput derivative of event likelihood

Definition at line 1244 of file model.h.

9.10.5.35 dJzdsigma

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

event sigma derivative of event likelihood

Definition at line 1246 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 1248 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 1250 of file model.h.

9.10.5.38 dzdx

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

state derivative of event output

Definition at line 1252 of file model.h.

9.10.5.39 dzdp

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

parameter derivative of event output

Definition at line 1254 of file model.h.

9.10.5.40 drzdx

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

state derivative of event timepoint

Definition at line 1256 of file model.h.

9.10.5.41 drzdp

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

parameter derivative of event timepoint

Definition at line 1258 of file model.h.

9.10.5.42 dydp

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

parameter derivative of observable

Definition at line 1260 of file model.h.

9.10.5.43 dydx

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

state derivative of observable

Definition at line 1262 of file model.h.

9.10.5.44 w

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

tempory storage of w data across functions

Definition at line 1264 of file model.h.

9.10.5.45 dwdx

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

tempory storage of dwdx data across functions

Definition at line 1266 of file model.h.

9.10.5.46 dwdp

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

tempory storage of dwdp data across functions

Definition at line 1268 of file model.h.

9.10.5.47 M

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

tempory storage of M data across functions

Definition at line 1270 of file model.h.

9.10.5.48 stau

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

tempory storage of stau data across functions

Definition at line 1272 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 1276 of file model.h.

9.10.5.50 unscaledParameters

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

unscaled parameters

Definition at line 1279 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 1282 of file model.h.

9.10.5.52 fixedParameters

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

constants

Definition at line 1285 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 1288 of file model.h.

9.10.5.54 x0data

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

state initialisation (size nx)

Definition at line 1291 of file model.h.

9.10.5.55 sx0data

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

sensitivity initialisation (size nx $*$ nplist)

Definition at line 1294 of file model.h.

9.10.5.56 ts

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

timepoints (size nt)

Definition at line 1297 of file model.h.

9.10.5.57 nmaxevent

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

maximal number of events to track

Definition at line 1300 of file model.h.

9.10.5.58 pscale

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

parameter transformation of p

Definition at line 1303 of file model.h.

9.10.5.59 tstart

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

starting time

Definition at line 1306 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:

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 ( ) [inline]
```

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 )  [inline]
```

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 )  [inline], [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 )  [inline], [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 )  [inline], [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 )  [inline], [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 )  [inline], [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 )  [inline], [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 )  [inline], [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 )  [inline], [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 )  [inline], [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 )  [inline], [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 )  [inline], [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 )  [inline], [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:

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 ( ) [inline]
```

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 )  [inline]
```

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 52 of file model_ode.h.

9.12.2.3 Model_ODE() [3/3]

```
Model_ODE (
            Model_ODE const & other )  [inline]
```

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 )  [inline], [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 )  [inline], [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 )  [inline], [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 )  [inline], [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 )  [inline], [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 )  [inline], [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 )  [inline], [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 )  [inline], [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 )  [inline], [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 )  [inline], [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 )  [inline], [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:

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 )  [inline]
```

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:

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)

Data Fields

- 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 Field 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:

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:

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:

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>
```

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)

Data Fields

- 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.

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.

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 Field 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 SBMLException Class Reference

Inheritance diagram for SBMLException:

9.19.1 Detailed Description

Definition at line 17 of file sbml_import.py.

9.20 SbmlImporter Class Reference

The SbmlImporter class generates AMICI C++ files for a model provided in the Systems Biology Markup Language (SBML).

Public Member Functions

- def __init__ (self, SBMLFile)

  Create a new Model instance.
- def loadSBMLFile (self, SBMLFile)

  Parse the provided SBML file.
- def sbml2amici (self, modelName, output_dir=None, observables={}, constantParameters=[ ], sigmas={})

  Generate AMICI C++ files for the model provided to the constructor.
- def setName (self, modelName)

  Sets the model name.
- def setPaths (self, output_dir=None)

  Set output paths for the model and create if necessary.
- def processSBML (self, constantParameters=[ ])

  Read parameters, species, reactions, and so on from SBML model.
- def checkSupport (self)

  Check whether all required SBML features are supported.
- def processSpecies (self)

  Get species information from SBML model.
- def processParameters (self, constantParameters=[ ])

  Get parameter information from SBML model.
- def processCompartments (self)

  Get compartment information, stoichiometric matrix and fluxes from SBML model.
- def processReactions (self)

  Get reactions from SBML model.
- def processRules (self)

  Process ∗Rules defined in the SBML model.
- def processVolumeConversion (self)

  Convert equations from amount to volume.
- def processTime (self)

  Convert time_symbol into cpp variable.
- def replaceInAllExpressions (self, old, new)

  Replace 'old' by 'new' in all symbolic expressions.
- def cleanReservedSymbols (self)

  Remove all reserved symbols from self.symbols.
- def replaceSpecialConstants (self)

  Replace all special constants by their respective SBML csymbol definition.
- def getSparseSymbols (self, symbolName)

  Create sparse symbolic matrix.
- def computeModelEquations (self, observables={}, sigmas={})

  Perform symbolic computations required to populate functions in `self.functions`.
- def computeModelEquationsLinearSolver (self)

  Perform symbolic computations required for the use of various linear solvers.
- def computeModelEquationsObjectiveFunction (self, observables={}, sigmas={})

  Perform symbolic computations required for objective function evaluation.
- def computeModelEquationsSensitivitesCore (self)

Perform symbolic computations required for any sensitivity analysis.

- def computeModelEquationsForwardSensitivites (self)

  Perform symbolic computations required for forward sensitivity analysis.
- def computeModelEquationsAdjointSensitivites (self)

  Perform symbolic computations required for adjoint sensitivity analysis.
- def prepareModelFolder (self)

  Remove all files from the model folder.
- def generateCCode (self)

  Create C++ code files for the model based on.
- def compileCCode (self)

  Compile the generated model code.
- def writeIndexFiles (self, name)

  Write index file for a symbolic array.
- def writeFunctionFile (self, function)

  Write the function `function`.
- def getFunctionBody (self, function)

  Generate C++ code for body of function `function`.
- def writeWrapfunctionsCPP (self)

  Write model-specific 'wrapper' file (wrapfunctions.cpp).
- def writeWrapfunctionsHeader (self)

  Write model-specific header file (wrapfunctions.h).
- def writeModelHeader (self)

  Write model-specific header file (MODELNAME.h).
- def writeCMakeFile (self)

  Write CMake CMakeLists.txt file for this model.
- def writeSwigFiles (self)

  Write SWIG interface files for this model.
- def writeModuleSetup (self)

  Create a distutils setup.py file for compile the model module.
- def getSymLines (self, symbols, variable, indentLevel)

  Generate C++ code for assigning symbolic terms in symbols to C++ array `variable`.
- def getSparseSymLines (self, symbolList, RowVals, ColPtrs, variable, indentLevel)

  Generate C++ code for assigning sparse symbolic matrix to a C++ array `variable`.
- def printWithException (self, math)

  Generate C++ code for a symbolic expression.

Data Fields

- Codeprinter

  codeprinter that allows
- functions

  dict carrying function specific definitions
- symbols

  symbolic definitions
- SBMLreader

  the libSBML sbml reader [!not storing this will result in a segfault!]
- sbml_doc

  document carrying the sbml defintion [!not storing this will result in a segfault!]
- sbml

  sbml definition [!not storing this will result in a segfault!]

- modelName

  name of the model that will be used for compilation
- modelPath

  path to the generated model specific files
- modelSwigPath

  path to the generated swig files
- n_species

  number of species
- speciesIndex

  dict that maps species names to indices
- speciesCompartment

  array of compartment for each species
- constantSpecies

  ids of species that are marked as constant
- boundaryConditionSpecies

  ids of species that are marked as boundary condition
- speciesHasOnlySubstanceUnits

  array of flags indicating whether a species has only substance units
- speciesInitial

  array of initial concentrations
- speciesConversionFactor

  array of conversion factors for every
- parameterValues

  array of parameter values
- n_parameters

  number of parameters
- parameterIndex

  dict that maps parameter names to indices
- fixedParameterValues

  array of fixed parameter values
- n_fixed_parameters

  number of fixed parameters
- fixedParameterIndex

  dict that maps fixed parameter names to indices
- compartmentSymbols

  array of compartment ids
- compartmentVolume

  array of compartment volumes
- n_reactions

  number of reactions
- stoichiometricMatrix

  stoichiometrix matrix of the model
- fluxVector

  vector of reaction kinetic laws
- observables

  array of observable definitions
- n_observables

  number of observables

9.20.1 Detailed Description

Definition at line 25 of file sbml_import.py.

9.20.2 Constructor & Destructor Documentation

9.20.2.1 __init__()

```
def __init__ (
              self,
              SBMLFile )
```

Parameters

SBMLFile	Path to SBML file where the model is specified

Returns

SbmlIMporter instance with attached SBML document

Definition at line 128 of file sbml_import.py.

Here is the call graph for this function:

9.20.3 Member Function Documentation

9.20.3.1 loadSBMLFile()

```
def loadSBMLFile (
              self,
              SBMLFile )
```

Parameters

SBMLFile	path to SBML file

Returns

Definition at line 254 of file sbml_import.py.

Here is the caller graph for this function:

9.20.3.2 sbml2amici()

```
def sbml2amici (
              self,
              modelName,
              output_dir = None,
              observables = {},
              constantParameters = [],
              sigmas = {} )
```

Parameters

modelName	name of the model/model directory
output_dir	see sbml_import.setPaths()
observables	dictionary(observableName:formulaString) to be added to the model
sigmas	dictionary(observableName: sigma value or (existing) parameter name)
constantParameters	list of SBML Ids identifying constant parameters

Returns

Definition at line 295 of file sbml_import.py.

Here is the call graph for this function:

9.20.3.3 setName()

```
def setName (
            self,
            modelName )
```

Parameters

modelName	name of the model (must only contain valid filename characters)

Returns

Definition at line 316 of file sbml_import.py.

Here is the caller graph for this function:

9.20.3.4 setPaths()

```
def setPaths (
              self,
              output_dir = None )
```

Parameters

output_dir	relative or absolute path where the generated model code is to be placed. will be created if does not exists. defaults to `pwd`/amici-$modelname.

Returns

Definition at line 330 of file sbml_import.py.

Here is the caller graph for this function:

9.20.3.5 processSBML()

```
def processSBML (
            self,
            constantParameters = [] )
```

Parameters

constantParameters	list of SBML Ids identifying constant parameters

Returns

Definition at line 353 of file sbml_import.py.

Here is the call graph for this function:

Here is the caller graph for this function:

9.20.3.6 checkSupport()

```
def checkSupport (
            self )
```

Returns

Definition at line 375 of file sbml_import.py.

Here is the caller graph for this function:

9.20.3.7 processSpecies()

```
def processSpecies (
            self )
```

Returns

Definition at line 406 of file sbml_import.py.

Here is the caller graph for this function:

9.20.3.8 processParameters()

```
def processParameters (
            self,
            constantParameters = [] )
```

Parameters

constantParameters	list of SBML Ids identifying constant parameters

Returns

Definition at line 446 of file sbml_import.py.

Here is the caller graph for this function:

9.20.3.9 processCompartments()

```
def processCompartments (
            self )
```

Returns

Definition at line 473 of file sbml_import.py.

Here is the caller graph for this function:

9.20.3.10 processReactions()

```
def processReactions (
              self )
```

Returns

Definition at line 491 of file sbml_import.py.

Here is the caller graph for this function:

9.20.3.11 processRules()

```
def processRules (
              self )
```

Returns

Definition at line 552 of file sbml_import.py.

Here is the caller graph for this function:

9.20.3.12 processVolumeConversion()

```
def processVolumeConversion (
              self )
```

Returns

Definition at line 605 of file sbml_import.py.

Here is the caller graph for this function:

9.20.3.13 processTime()

```
def processTime (
              self )
```

Returns

Definition at line 623 of file sbml_import.py.

Here is the call graph for this function:

Here is the caller graph for this function:

9.20.3.14 replaceInAllExpressions()

```
def replaceInAllExpressions (
              self,
              old,
              new )
```

Parameters

old	symbolic variables to be replaced
new	replacement symbolic variables

Returns

Definition at line 642 of file sbml_import.py.

Here is the caller graph for this function:

9.20.3.15 cleanReservedSymbols()

```
def cleanReservedSymbols (
              self )
```

Returns

Definition at line 658 of file sbml_import.py.

Here is the call graph for this function:

Here is the caller graph for this function:

9.20.3.16 replaceSpecialConstants()

```
def replaceSpecialConstants (
              self )
```

Returns

Definition at line 677 of file sbml_import.py.

Here is the call graph for this function:

Here is the caller graph for this function:

9.20.3.17 getSparseSymbols()

```
def getSparseSymbols (
              self,
              symbolName )
```

Parameters

symbolName	name of the function

Returns

sparseMatrix sparse matrix containing symbolic entries
symbolList symbolic vector containing the list of symbol names
sparseList symbolic vector containing the list of symbol formulas
symbolColPtrs Column pointer as specified in the SlsMat definition in CVODES
symbolRowVals Row Values as specified in the SlsMat definition in CVODES

Definition at line 705 of file sbml_import.py.

Here is the caller graph for this function:

9.20.3.18 computeModelEquations()

```
def computeModelEquations (
              self,
              observables = {},
              sigmas = {} )
```

Parameters

observables	dictionary(observableName:formulaString) to be added to the model
sigmas	dictionary(observableName: sigma value or (existing) parameter name)

Returns

Definition at line 738 of file sbml_import.py.

Here is the call graph for this function:

Here is the caller graph for this function:

9.20.3.19 computeModelEquationsLinearSolver()

```
def computeModelEquationsLinearSolver (
              self )
```

Returns

Definition at line 760 of file sbml_import.py.

Here is the call graph for this function:

Here is the caller graph for this function:

9.20.3.20 computeModelEquationsObjectiveFunction()

```
def computeModelEquationsObjectiveFunction (
              self,
              observables = {},
              sigmas = {} )
```

Parameters

observables	dictionary(observableName:formulaString) to be added to the model
sigmas	dictionary(observableName: sigma value or (existing) parameter name)

Returns

Definition at line 794 of file sbml_import.py.

Here is the caller graph for this function:

9.20.3.21 computeModelEquationsSensitivitesCore()

```
def computeModelEquationsSensitivitesCore (
              self )
```

Returns

Definition at line 838 of file sbml_import.py.

Here is the call graph for this function:

Here is the caller graph for this function:

9.20.3.22 computeModelEquationsForwardSensitivites()

```
def computeModelEquationsForwardSensitivites (
              self )
```

Returns

Definition at line 867 of file sbml_import.py.

Here is the caller graph for this function:

9.20.3.23 computeModelEquationsAdjointSensitivites()

```
def computeModelEquationsAdjointSensitivites (
              self )
```

Returns

Definition at line 882 of file sbml_import.py.

Here is the call graph for this function:

Here is the caller graph for this function:

9.20.3.24 prepareModelFolder()

```
def prepareModelFolder (
              self )
```

Returns

Definition at line 907 of file sbml_import.py.

Here is the caller graph for this function:

9.20.3.25 generateCCode()

```
def generateCCode (
            self )
```

Returns

Definition at line 924 of file sbml_import.py.

Here is the call graph for this function:

Here is the caller graph for this function:

9.20.3.26 compileCCode()

```
def compileCCode (
            self )
```

Returns

Definition at line 951 of file sbml_import.py.

Here is the caller graph for this function:

9.20.3.27 writeIndexFiles()

```
def writeIndexFiles (
              self,
              name )
```

Parameters

name	key in self.symbols for which the respective file should be written

Returns

Definition at line 974 of file sbml_import.py.

Here is the caller graph for this function:

9.20.3.28 writeFunctionFile()

```
def writeFunctionFile (
              self,
              function )
```

Parameters

function	name of the function to be written (see self.functions)

Returns

Definition at line 992 of file sbml_import.py.

Here is the call graph for this function:

Here is the caller graph for this function:

9.20.3.29 getFunctionBody()

```
def getFunctionBody (
            self,
            function )
```

Parameters

function	name of the function to be written (see self.functions)

Returns

Definition at line 1039 of file sbml_import.py.

Here is the call graph for this function:

Here is the caller graph for this function:

9.20.3.30 writeWrapfunctionsCPP()

```
def writeWrapfunctionsCPP (
              self )
```

Returns

Definition at line 1087 of file sbml_import.py.

Here is the caller graph for this function:

9.20.3.31 writeWrapfunctionsHeader()

```
def writeWrapfunctionsHeader (
              self )
```

Returns

Definition at line 1102 of file sbml_import.py.

Here is the caller graph for this function:

9.20.3.32 writeModelHeader()

```
def writeModelHeader (
              self )
```

Returns

Definition at line 1116 of file sbml_import.py.

Here is the caller graph for this function:

9.20.3.33 writeCMakeFile()

```
def writeCMakeFile (
              self )
```

Returns

Definition at line 1149 of file sbml_import.py.

Here is the caller graph for this function:

9.20.3.34 writeSwigFiles()

```
def writeSwigFiles (
              self )
```

Returns

Definition at line 1170 of file sbml_import.py.

Here is the caller graph for this function:

9.20.3.35 writeModuleSetup()

```
def writeModuleSetup (
              self )
```

Returns

Definition at line 1188 of file sbml_import.py.

Here is the caller graph for this function:

9.20.3.36 getSymLines()

```
def getSymLines (
              self,
              symbols,
              variable,
              indentLevel )
```

Parameters

symbols	vectors of symbolic terms
variable	name of the C++ array to assign to
indentLevel	indentation level (number of leading blanks)

Returns

C++ code as list of lines

Definition at line 1215 of file sbml_import.py.

Here is the call graph for this function:

Here is the caller graph for this function:

9.20.3.37 getSparseSymLines()

```
def getSparseSymLines (
              self,
              symbolList,
              RowVals,
              ColPtrs,
              variable,
              indentLevel )
```

Parameters

symbolList	vectors of symbolic terms
RowVals	list of row indices of each nonzero entry (see CVODES SlsMat documentation for details)
ColPtrs	list of indices of the first column entries (see CVODES SlsMat documentation for details)
variable	name of the C++ array to assign to
indentLevel	indentation level (number of leading blanks)

Returns

C++ code as list of lines

Definition at line 1242 of file sbml_import.py.

Here is the call graph for this function:

Here is the caller graph for this function:

9.20.3.38 printWithException()

```
def printWithException (
            self,
            math )
```

Parameters

math	symbolic expression

Returns

C++ code for the specified expression

Exceptions

SBMLException	The specified expression containted an unsupported function

Definition at line 1265 of file sbml_import.py.

Here is the caller graph for this function:

9.21 TemplateAmici Class Reference

Template format used in AMICI (see string.template for more details).

Inheritance diagram for TemplateAmici:

Static Public Attributes

- string delimiter = 'TPL_'

  delimiter that identifies template variables

9.21.1 Detailed Description

Returns

Definition at line 1337 of file sbml_import.py.

9.22 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:

Public Member Functions

- SetupFailure (const char *msg)

9.22.1 Detailed Description

Definition at line 166 of file exception.h.

9.22.2 Constructor & Destructor Documentation

9.22.2.1 SetupFailure()

```
SetupFailure (
            const char * msg )  [inline]
```

constructor, simply calls AmiException constructor

Parameters

in	*msg*	

Definition at line 171 of file exception.h.

9.23 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 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.

9.23.1 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.

9.23.2 Constructor & Destructor Documentation

9.23.2.1 Solver()

```
Solver (
            const Solver & other )  [inline]
```

Parameters

other	

Definition at line 46 of file solver.h.

9.23.3 Member Function Documentation

9.23.3.1 clone()

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

Returns

The clone

9.23.3.2 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:

9.23.3.3 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:

9.23.3.4 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

9.23.3.5 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:

9.23.3.6 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:

9.23.3.7 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

9.23.3.8 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)

9.23.3.9 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)

9.23.3.10 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:

9.23.3.11 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:

9.23.3.12 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:

9.23.3.13 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:

9.23.3.14 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:

9.23.3.15 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:

9.23.3.16 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:

9.23.3.17 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:

9.23.3.18 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:

9.23.3.19 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:

9.23.3.20 turnOffRootFinding()

```
virtual void turnOffRootFinding ( )  [pure virtual]
```

turnOffRootFinding disables rootfinding Here is the caller graph for this function:

9.23.3.21 getSensitivityMethod()

```
AMICI_sensi_meth getSensitivityMethod ( ) const  [inline]
```

sensitivity method

Returns

method enum

Definition at line 243 of file solver.h.

9.23.3.22 setSensitivityMethod()

```
void setSensitivityMethod (
            AMICI_sensi_meth sensi_meth )  [inline]
```

Parameters

sensi_meth	

Definition at line 251 of file solver.h.

9.23.3.23 getNewtonMaxSteps()

```
int getNewtonMaxSteps ( ) const  [inline]
```

Returns

Definition at line 259 of file solver.h.

9.23.3.24 setNewtonMaxSteps()

```
void setNewtonMaxSteps (
            int newton_maxsteps )  [inline]
```

Parameters

newton_maxsteps	

Definition at line 267 of file solver.h.

9.23.3.25 getNewtonPreequilibration()

```
bool getNewtonPreequilibration ( ) const  [inline]
```

Returns

Definition at line 275 of file solver.h.

Here is the caller graph for this function:

9.23.3.26 setNewtonPreequilibration()

```
void setNewtonPreequilibration (
            bool newton_preeq )  [inline]
```

Parameters

newton_preeq	

Definition at line 283 of file solver.h.

9.23.3.27 getNewtonMaxLinearSteps()

```
int getNewtonMaxLinearSteps ( ) const  [inline]
```

Returns

Definition at line 292 of file solver.h.

9.23.3.28 setNewtonMaxLinearSteps()

```
void setNewtonMaxLinearSteps (
            int newton_maxlinsteps )  [inline]
```

Parameters

newton_maxlinsteps	

Definition at line 300 of file solver.h.

9.23.3.29 getSensitivityOrder()

```
AMICI_sensi_order getSensitivityOrder ( ) const  [inline]
```

Returns

Definition at line 308 of file solver.h.

9.23.3.30 setSensitivityOrder()

```
void setSensitivityOrder (
            AMICI_sensi_order sensi )  [inline]
```

Parameters

sensi	

Definition at line 316 of file solver.h.

9.23.3.31 getRelativeTolerance()

```
double getRelativeTolerance ( ) const  [inline]
```

Returns

Definition at line 333 of file solver.h.

9.23.3.32 setRelativeTolerance()

```
void setRelativeTolerance (
            double rtol )  [inline]
```

Parameters

rtol	

Definition at line 341 of file solver.h.

9.23.3.33 getAbsoluteTolerance()

```
double getAbsoluteTolerance ( ) const  [inline]
```

Returns

Definition at line 349 of file solver.h.

9.23.3.34 setAbsoluteTolerance()

```
void setAbsoluteTolerance (
            double atol )  [inline]
```

Parameters

atol	

Definition at line 357 of file solver.h.

9.23.3.35 getRelativeToleranceQuadratures()

```
double getRelativeToleranceQuadratures ( ) const  [inline]
```

Returns

Definition at line 365 of file solver.h.

9.23.3.36 setRelativeToleranceQuadratures()

```
void setRelativeToleranceQuadratures (
            double rtol )  [inline]
```

Parameters

rtol	

Definition at line 373 of file solver.h.

9.23.3.37 getAbsoluteToleranceQuadratures()

```
double getAbsoluteToleranceQuadratures ( ) const  [inline]
```

Returns

Definition at line 381 of file solver.h.

9.23.3.38 setAbsoluteToleranceQuadratures()

```
void setAbsoluteToleranceQuadratures (
            double atol )  [inline]
```

Parameters

atol	

Definition at line 389 of file solver.h.

9.23.3.39 getMaxSteps()

```
int getMaxSteps ( ) const  [inline]
```

Returns

Definition at line 397 of file solver.h.

9.23.3.40 setMaxSteps()

```
void setMaxSteps (
            int maxsteps )  [inline]
```

Parameters

maxsteps	

Definition at line 405 of file solver.h.

9.23.3.41 getMaxStepsBackwardProblem()

```
int getMaxStepsBackwardProblem ( ) const  [inline]
```

Returns

Definition at line 413 of file solver.h.

9.23.3.42 setMaxStepsBackwardProblem()

```
void setMaxStepsBackwardProblem (
            int maxsteps )  [inline]
```

Parameters

maxsteps	

Definition at line 421 of file solver.h.

9.23.3.43 getLinearMultistepMethod()

```
LinearMultistepMethod getLinearMultistepMethod ( ) const  [inline]
```

Returns

Definition at line 429 of file solver.h.

9.23.3.44 setLinearMultistepMethod()

```
void setLinearMultistepMethod (
            LinearMultistepMethod lmm )  [inline]
```

Parameters

lmm	

Definition at line 437 of file solver.h.

9.23.3.45 getNonlinearSolverIteration()

```
NonlinearSolverIteration getNonlinearSolverIteration ( ) const  [inline]
```

Returns

Definition at line 448 of file solver.h.

9.23.3.46 setNonlinearSolverIteration()

```
void setNonlinearSolverIteration (
            NonlinearSolverIteration iter )  [inline]
```

Parameters

iter	

Definition at line 456 of file solver.h.

9.23.3.47 getInterpolationType()

```
InterpolationType getInterpolationType ( ) const  [inline]
```

Returns

Definition at line 467 of file solver.h.

9.23.3.48 setInterpolationType()

```
void setInterpolationType (
            InterpolationType interpType )  [inline]
```

Parameters

interpType	

Definition at line 475 of file solver.h.

9.23.3.49 getStateOrdering()

```
StateOrdering getStateOrdering ( ) const  [inline]
```

Returns

Definition at line 483 of file solver.h.

Here is the caller graph for this function:

9.23.3.50 setStateOrdering()

```
void setStateOrdering (
            StateOrdering ordering )  [inline]
```

Parameters

ordering	

Definition at line 491 of file solver.h.

9.23.3.51 getStabilityLimitFlag()

```
int getStabilityLimitFlag ( ) const  [inline]
```

Returns

Definition at line 499 of file solver.h.

9.23.3.52 setStabilityLimitFlag()

```
void setStabilityLimitFlag (
            int stldet )  [inline]
```

Parameters

stldet	

Definition at line 507 of file solver.h.

9.23.3.53 getLinearSolver()

```
LinearSolver getLinearSolver ( ) const  [inline]
```

Returns

Definition at line 515 of file solver.h.

9.23.3.54 setLinearSolver()

```
void setLinearSolver (
            LinearSolver linsol )  [inline]
```

Parameters

linsol	

Definition at line 523 of file solver.h.

9.23.3.55 getInternalSensitivityMethod()

```
InternalSensitivityMethod getInternalSensitivityMethod ( ) const  [inline]
```

Returns

Definition at line 531 of file solver.h.

9.23.3.56 setInternalSensitivityMethod()

```
void setInternalSensitivityMethod (
            InternalSensitivityMethod ism )  [inline]
```

Parameters

ism	

Definition at line 539 of file solver.h.

9.23.3.57 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:

9.23.3.58 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:

9.23.3.59 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:

9.23.3.60 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:

9.23.3.61 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:

9.23.3.62 setDenseJacFn()

```
virtual void setDenseJacFn ( )  [protected], [pure virtual]
```

SetDenseJacFn sets the dense Jacobian function Here is the caller graph for this function:

9.23.3.63 setSparseJacFn()

```
virtual void setSparseJacFn ( )  [protected], [pure virtual]
```

SetSparseJacFn sets the sparse Jacobian function Here is the caller graph for this function:

9.23.3.64 setBandJacFn()

```
virtual void setBandJacFn ( )  [protected], [pure virtual]
```

SetBandJacFn sets the banded Jacobian function Here is the caller graph for this function:

9.23.3.65 setJacTimesVecFn()

```
virtual void setJacTimesVecFn ( )  [protected], [pure virtual]
```

SetJacTimesVecFn sets the Jacobian vector multiplication function Here is the caller graph for this function:

9.23.3.66 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:

9.23.3.67 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:

9.23.3.68 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:

9.23.3.69 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:

9.23.3.70 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.

9.23.3.71 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:

9.23.3.72 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:

9.23.3.73 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:

9.23.3.74 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:

9.23.3.75 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:

9.23.3.76 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:

9.23.3.77 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:

9.23.3.78 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:

9.23.3.79 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:

9.23.3.80 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:

9.23.3.81 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:

9.23.3.82 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:

9.23.3.83 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:

9.23.3.84 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:

9.23.3.85 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:

9.23.3.86 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

9.23.3.87 AMIFree()

```
virtual void AMIFree ( )  [protected], [pure virtual]
```

AMIFree frees allocation solver memory Here is the caller graph for this function:

9.23.3.88 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:

9.23.3.89 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:

9.23.3.90 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:

9.23.3.91 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:

9.23.3.92 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:

9.23.3.93 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:

9.23.3.94 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:

9.23.3.95 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:

9.23.3.96 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:

9.23.3.97 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:

9.23.3.98 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:

9.23.3.99 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:

9.23.3.100 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:

9.23.3.101 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:

9.23.3.102 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:

9.23.3.103 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:

9.23.3.104 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:

9.23.3.105 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:

9.23.3.106 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:

9.23.3.107 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:

9.23.3.108 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:

9.23.3.109 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:

9.23.3.110 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:

9.23.3.111 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:

9.23.3.112 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:

9.23.3.113 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:

9.23.3.114 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:

9.23.3.115 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:

9.23.4 Friends And Related Function Documentation

9.23.4.1 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

9.23.4.2 operator==

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

Parameters

a	
b	

Returns

Definition at line 424 of file solver.cpp.

9.23.5 Field Documentation

9.23.5.1 ami_mem

```
void* ami_mem = nullptr  [protected]
```

pointer to ami memory block

Definition at line 1058 of file solver.h.

9.23.5.2 solverWasCalled

```
bool solverWasCalled = false  [protected]
```

flag indicating whether the solver was called

Definition at line 1061 of file solver.h.

9.24 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)

9.24.1 Detailed Description

Definition at line 22 of file steadystateproblem.h.

9.24.2 Constructor & Destructor Documentation

9.24.2.1 SteadystateProblem()

```
SteadystateProblem (
            realtype * t,
            AmiVector * x,
            AmiVectorArray * sx )  [inline]
```

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.

9.24.3 Member Function Documentation

9.24.3.1 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:

9.24.3.2 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:

9.24.3.3 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:

9.24.3.4 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:

9.25 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:

Public Member Functions

- amidata (matlabtypesubstitute varargin)

  amidata creates an amidata container for experimental data with specified dimensions amidata.

Data Fields

- 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

9.25.1 Detailed Description

Definition at line 17 of file amidata.m.

9.25.2 Constructor & Destructor Documentation

9.25.2.1 amidata()

```
amidata (
            matlabtypesubstitute varargin )  [inline]
```

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.

9.25.3 Field Documentation

9.25.3.1 nt

```
nt = 0
```

Default: 0

Note

This property has custom functionality when its value is changed.

Definition at line 31 of file amidata.m.

9.25.3.2 ny

```
ny = 0
```

Default: 0

Note

This property has custom functionality when its value is changed.

Definition at line 39 of file amidata.m.

9.25.3.3 nz

```
nz = 0
```

Default: 0

Note

This property has custom functionality when its value is changed.

Definition at line 47 of file amidata.m.

9.25.3.4 ne

```
ne = 0
```

Default: 0

Note

This property has custom functionality when its value is changed.

Definition at line 55 of file amidata.m.

9.25.3.5 nk

```
nk = 0
```

Default: 0

Note

This property has custom functionality when its value is changed.

Definition at line 63 of file amidata.m.

9.25.3.6 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.

9.25.3.7 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.

9.25.3.8 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.

9.25.3.9 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.

9.25.3.10 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.

9.25.3.11 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.

9.25.3.12 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.

9.26 amievent Class Reference

AMIEVENT defines events which later on will be transformed into appropriate C code.

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.

Data Fields

- ::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

9.26.1 Detailed Description

Definition at line 17 of file amievent.m.

9.26.2 Constructor & Destructor Documentation

9.26.2.1 amievent()

```
amievent (
            matlabtypesubstitute trigger,
            matlabtypesubstitute bolus,
            matlabtypesubstitute z )  [inline]
```

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.

9.26.3 Member Function Documentation

9.26.3.1 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:

9.26.4 Field Documentation

9.26.4.1 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.

9.26.4.2 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.

9.26.4.3 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.

9.26.4.4 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.

9.27 amifun Class Reference

AMIFUN defines functions which later on will be transformed into appropriate C code.

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

Data Fields

- ::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

9.27.1 Detailed Description

Definition at line 17 of file amifun.m.

9.27.2 Constructor & Destructor Documentation

9.27.2.1 amifun()

```
amifun (
            matlabtypesubstitute funstr,
            matlabtypesubstitute model )  [inline]
```

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.

9.27.3 Member Function Documentation

9.27.3.1 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.

9.27.3.2 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:

9.27.3.3 writeMcode()

```
noret::substitute writeMcode (
            ::amimodel model )
```

Parameters

model	model defintion object

Return values

model	void

Definition at line 18 of file writeMcode.m.

9.27.3.4 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:

9.27.3.5 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.

9.27.3.6 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.

9.27.3.7 getNVecs()

```
mlhsInnerSubst<::amifun > getNVecs ( )
```

Return values

this	updated function definition object

Definition at line 18 of file getNVecs.m.

9.27.3.8 getCVar()

```
mlhsInnerSubst<::amifun > getCVar ( )
```

Return values

this	updated function definition object

Definition at line 18 of file getCVar.m.

9.27.3.9 getSensiFlag()

```
mlhsInnerSubst<::amifun > getSensiFlag ( )
```

Return values

this	updated function definition object

Definition at line 18 of file getSensiFlag.m.

9.27.3.10 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.

9.27.4 Field Documentation

9.27.4.1 sym

```
sym = sym("[]")
```

Default: sym("[]")

Definition at line 27 of file amifun.m.

9.27.4.2 sym_noopt

```
sym_noopt = sym("[]")
```

Default: sym("[]")

Definition at line 35 of file amifun.m.

9.27.4.3 strsym

```
strsym = sym("[]")
```

Default: sym("[]")

Definition at line 43 of file amifun.m.

9.27.4.4 strsym_old

```
strsym_old = sym("[]")
```

Default: sym("[]")

Definition at line 51 of file amifun.m.

9.27.4.5 funstr

```
funstr = char.empty("")
```

Default: char.empty("")

Definition at line 59 of file amifun.m.

9.27.4.6 cvar

```
cvar = char.empty("")
```

Default: char.empty("")

Definition at line 67 of file amifun.m.

9.27.4.7 argstr

```
argstr = char.empty("")
```

Default: char.empty("")

Definition at line 75 of file amifun.m.

9.27.4.8 deps

```
deps = cell.empty("")
```

Default: cell.empty("")

Definition at line 83 of file amifun.m.

9.27.4.9 nvecs

```
nvecs = cell.empty("")
```

Default: cell.empty("")

Definition at line 91 of file amifun.m.

9.27.4.10 sensiflag

```
sensiflag = logical.empty("")
```

Default: logical.empty("")

Definition at line 99 of file amifun.m.

9.28 amimodel Class Reference

AMIMODEL carries all model definitions including functions and events.

Inheritance 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.

Data Fields

- ::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

9.28.1 Detailed Description

Definition at line 17 of file amimodel.m.

9.28.2 Constructor & Destructor Documentation

9.28.2.1 amimodel()

```
amimodel (
            ::string symfun,
            ::string modelname )  [inline]
```

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:

9.28.3 Member Function Documentation

9.28.3.1 updateRHS()

```
noret::substitute updateRHS (
            matlabtypesubstitute xdot )  [inline]
```

Parameters

xdot	new right hand side of the differential equation

Return values

xdot	void

Definition at line 612 of file amimodel.m.

9.28.3.2 updateModelName()

```
noret::substitute updateModelName (
            matlabtypesubstitute modelname )  [inline]
```

Parameters

modelname	new modelname

Return values

modelname	void

Definition at line 627 of file amimodel.m.

9.28.3.3 updateWrapPath()

```
noret::substitute updateWrapPath (
            matlabtypesubstitute wrap_path )  [inline]
```

Parameters

wrap_path	new wrap_path

Return values

wrap_path	void

Definition at line 640 of file amimodel.m.

9.28.3.4 parseModel()

```
noret::substitute parseModel ( )
```

Return values

void	

Definition at line 18 of file parseModel.m.

Here is the call graph for this function:

9.28.3.5 generateC()

```
noret::substitute generateC ( )
```

Return values

void	

Definition at line 18 of file generateC.m.

9.28.3.6 compileC()

```
noret::substitute compileC ( )
```

Return values

void	

Definition at line 18 of file compileC.m.

Here is the call graph for this function:

9.28.3.7 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:

9.28.3.8 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:

9.28.3.9 makeEvents()

```
noret::substitute makeEvents ( )
```

Return values

void	

Definition at line 18 of file makeEvents.m.

Here is the call graph for this function:

9.28.3.10 makeSyms()

```
noret::substitute makeSyms ( )
```

Return values

void	

Definition at line 18 of file makeSyms.m.

9.28.3.11 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:

9.28.3.12 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:

9.28.3.13 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:

9.28.3.14 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:

9.28.3.15 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:

9.28.3.16 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:

9.28.4 Field Documentation

9.28.4.1 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.

9.28.4.2 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.

9.28.4.3 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.

9.28.4.4 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.

9.28.4.5 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.

9.28.4.6 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.

9.28.4.7 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.

9.28.4.8 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.

9.28.4.9 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.

9.28.4.10 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.

9.28.4.11 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.

9.28.4.12 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.

9.28.4.13 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.

9.28.4.14 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.

9.28.4.15 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.

9.28.4.16 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.

9.28.4.17 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.

9.28.4.18 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.

9.28.4.19 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.

9.28.4.20 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.

9.28.4.21 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.

9.28.4.22 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.

9.28.4.23 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.

9.28.4.24 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.

9.28.4.25 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.

9.28.4.26 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.

9.28.4.27 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.

9.28.4.28 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.

9.28.4.29 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.

9.28.4.30 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.

9.28.4.31 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.

9.28.4.32 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.

9.28.4.33 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.

9.28.4.34 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.

9.28.4.35 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.

9.28.4.36 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.

9.28.4.37 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.

9.28.4.38 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.

9.28.4.39 z2event

```
z2event = double.empty("")
```

Default: double.empty("")

Definition at line 455 of file amimodel.m.

9.28.4.40 splineflag

```
splineflag = false
```

Default: false

Definition at line 463 of file amimodel.m.

9.28.4.41 minflag

```
minflag = false
```

Default: false

Definition at line 471 of file amimodel.m.

9.28.4.42 maxflag

```
maxflag = false
```

Default: false

Definition at line 479 of file amimodel.m.

9.28.4.43 nw

```
nw = 0
```

Default: 0

Definition at line 487 of file amimodel.m.

9.28.4.44 ndwdx

```
ndwdx = 0
```

Default: 0

Definition at line 496 of file amimodel.m.

9.28.4.45 ndwdp

```
ndwdp = 0
```

Default: 0

Definition at line 504 of file amimodel.m.

9.29 amioption Class Reference

AMIOPTION provides an option container to pass simulation parameters to the simulation routine.

Inheritance 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.

Data Fields

- 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 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_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`)

9.29.1 Detailed Description

Definition at line 17 of file amioption.m.

9.29.2 Constructor & Destructor Documentation

9.29.2.1 amioption()

```
amioption (
            matlabtypesubstitute varargin )  [inline]
```

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 242 of file amioption.m.

9.29.3 Field Documentation

9.29.3.1 atol

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

Default: 1e-16

Definition at line 28 of file amioption.m.

9.29.3.2 rtol

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

Default: 1e-8

Definition at line 36 of file amioption.m.

9.29.3.3 maxsteps

```
maxsteps = 1e4
```

Default: 1e4

Definition at line 44 of file amioption.m.

9.29.3.4 quad_atol

```
quad_atol = 1e-12
```

Default: 1e-12

Definition at line 52 of file amioption.m.

9.29.3.5 quad_rtol

```
quad_rtol = 1e-8
```

Default: 1e-8

Definition at line 60 of file amioption.m.

9.29.3.6 maxstepsB

```
maxstepsB = 0
```

Default: 0

Definition at line 68 of file amioption.m.

9.29.3.7 sens_ind

```
sens_ind = double.empty("")
```

Default: double.empty("")

Definition at line 76 of file amioption.m.

9.29.3.8 tstart

```
tstart = 0
```

Default: 0

Definition at line 84 of file amioption.m.

9.29.3.9 lmm

```
lmm = 2
```

Default: 2

Definition at line 92 of file amioption.m.

9.29.3.10 iter

```
iter = 2
```

Default: 2

Definition at line 100 of file amioption.m.

9.29.3.11 linsol

```
linsol = 9
```

Default: 9

Definition at line 108 of file amioption.m.

9.29.3.12 stldet

```
stldet = true
```

Default: true

Definition at line 116 of file amioption.m.

9.29.3.13 interpType

```
interpType = 1
```

Default: 1

Definition at line 124 of file amioption.m.

9.29.3.14 ism

```
ism = 1
```

Default: 1

Definition at line 132 of file amioption.m.

9.29.3.15 sensi_meth

```
sensi_meth = 1
```

Default: 1

Note

This property has custom functionality when its value is changed.

Definition at line 140 of file amioption.m.

9.29.3.16 sensi

```
sensi = 0
```

Default: 0

Note

This property has custom functionality when its value is changed.

Definition at line 148 of file amioption.m.

9.29.3.17 nmaxevent

```
nmaxevent = 10
```

Default: 10

Definition at line 156 of file amioption.m.

9.29.3.18 ordering

```
ordering = 0
```

Default: 0

Definition at line 164 of file amioption.m.

9.29.3.19 ss

```
ss = 0
```

Default: 0

Definition at line 172 of file amioption.m.

9.29.3.20 x0

```
x0 = double.empty("")
```

Default: double.empty("")

Definition at line 180 of file amioption.m.

9.29.3.21 sx0

```
sx0 = double.empty("")
```

Default: double.empty("")

Definition at line 188 of file amioption.m.

9.29.3.22 newton_maxsteps

```
newton_maxsteps = 40
```

Default: 40

Note

This property has custom functionality when its value is changed.

Definition at line 196 of file amioption.m.

9.29.3.23 newton_maxlinsteps

```
newton_maxlinsteps = 100
```

Default: 100

Note

This property has custom functionality when its value is changed.

Definition at line 204 of file amioption.m.

9.29.3.24 newton_preeq

```
newton_preeq = false
```

Default: false

Note

This property has custom functionality when its value is changed.

Definition at line 212 of file amioption.m.

9.29.3.25 z2event

```
z2event = double.empty("")
```

Default: double.empty("")

Definition at line 220 of file amioption.m.

9.29.3.26 pscale

```
pscale = ""
```

Default: ""

Note

This property has custom functionality when its value is changed.

Definition at line 228 of file amioption.m.

9.30 amised Class Reference

AMISED is a container for SED-ML objects.

Inheritance diagram for amised:

Public Member Functions

- amised (matlabtypesubstitute sedname)

  amised reads in an SEDML document using the JAVA binding of of libSEDML

Data Fields

- 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

9.30.1 Detailed Description

Definition at line 17 of file amised.m.

9.30.2 Constructor & Destructor Documentation

9.30.2.1 amised()

```
amised (
            matlabtypesubstitute sedname )  [inline]
```

Parameters

sedname	name/path of the SEDML document

Definition at line 112 of file amised.m.

9.30.3 Field Documentation

9.30.3.1 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.

9.30.3.2 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.

9.30.3.3 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.

9.30.3.4 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.

9.30.3.5 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.

9.30.3.6 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.

9.30.3.7 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.

9.31 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:

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

9.31.1 Detailed Description

Definition at line 17 of file optsym.m.

9.31.2 Constructor & Destructor Documentation

9.31.2.1 optsym()

```
optsym (
            ::sym symbol )  [inline]
```

Parameters

symbol	symbolic object

Definition at line 32 of file optsym.m.

9.31.3 Member Function Documentation

9.31.3.1 getoptimized()

```
mlhsInnerSubst<::sym > getoptimized ( )  [inline]
```

Return values

out	optimized symbolic object

Definition at line 42 of file optsym.m.

Index

__init__
amici::sbml_import::SbmlImporter, 248
~AmiVector
amici::AmiVector, 18
~AmiVectorArray
amici::AmiVectorArray, 26
~ForwardProblem
amici::ForwardProblem, 45
~Model
amici::Model, 63

AMIAdjInit
amici::Solver, 316
AMIBand
amici::Solver, 319
AMIBandB
amici::Solver, 320
AMICalcICB
amici::Solver, 287
AMICalcIC
amici::Solver, 286
AMICreate
amici::Solver, 308
AMICreateB
amici::Solver, 317
AMIDense
amici::Solver, 318
AMIDenseB
amici::Solver, 319
AMIDiag
amici::Solver, 320
AMIDiagB
amici::Solver, 321
AMIFree
amici::Solver, 316
AMIGetAdjBmem
amici::Solver, 329
AMIGetDky
amici::Solver, 315
AMIGetLastOrder
amici::Solver, 328
AMIGetNumErrTestFails
amici::Solver, 327
AMIGetNumNonlinSolvConvFails
amici::Solver, 328
AMIGetNumRhsEvals
amici::Solver, 327
AMIGetNumSteps
amici::Solver, 326
AMIGetQuadB
amici::Solver, 291
AMIGetRootInfo
amici::Solver, 285
AMIGetSens
amici::Solver, 283
AMIGetB
amici::Solver, 290
AMIKLUSetOrdering
amici::Solver, 325
AMIKLUSetOrderingB
amici::Solver, 325
AMIKLUB
amici::Solver, 326
AMIKLU
amici::Solver, 324
AMIQuadReInitB
amici::Solver, 292
AMIQuadSStolerancesB
amici::Solver, 318
AMIReInit
amici::Solver, 285
AMIReInitB
amici::Solver, 290
AMISStolerances
amici::Solver, 309
AMISStolerancesB
amici::Solver, 317
AMISensReInit
amici::Solver, 286
AMISensSStolerances
amici::Solver, 309
AMISetErrHandlerFn
amici::Solver, 311
AMISetId
amici::Solver, 314
AMISetMaxNumSteps
amici::Solver, 312
AMISetMaxNumStepsB
amici::Solver, 312
AMISetQuadErrConB
amici::Solver, 310
AMISetSensErrCon
amici::Solver, 310
AMISetSensParams
amici::Solver, 315
AMISetStabLimDet
amici::Solver, 313
AMISetStabLimDetB
amici::Solver, 313
AMISetStopTime
amici::Solver, 289
AMISetSuppressAlg
amici::Solver, 314
AMISetUserData
amici::Solver, 311
AMISetUserDataB
amici::Solver, 312
AMISolve
amici::Solver, 287
AMISolveB

amici::Solver, 289
AMISolveF
amici::Solver, 288
AMISpbcg
amici::Solver, 322
AMISpbcgB
amici::Solver, 323
AMISpgmr
amici::Solver, 321
AMISpgmrB
amici::Solver, 322
AMISptfqmr
amici::Solver, 323
AMISptfqmrB
amici::Solver, 324
adjoint
amimodel, 369
ami_mem
amici::Solver, 334
AmiException, 14
amici::AmiException, 14, 15
AmiVector, 16
amici::AmiVector, 17, 18
AmiVectorArray, 24
amici::AmiVectorArray, 24, 26
amici::AmiException
AmiException, 14, 15
getBacktrace, 15
storeBacktrace, 16
what, 15
amici::AmiVector
∼AmiVector, 18
AmiVector, 17, 18
at, 23
data, 19, 20
getLength, 21
getNVector, 20
getVector, 21
minus, 22
operator=, 18
operator[], 23
reset, 22
set, 22
amici::AmiVectorArray
∼AmiVectorArray, 26
AmiVectorArray, 24, 26
at, 28
data, 27
getLength, 30
getNVector, 29
getNVectorArray, 28
operator[], 29
reset, 30
amici::BackwardProblem
BackwardProblem, 31
getdJydx, 36
getdxBptr, 35
gett, 33
getwhich, 34
getwhichptr, 34
getxBptr, 34
getxQBptr, 35
workBackwardProblem, 32
amici::CvodeException
CvodeException, 37
amici::ExpData
ExpData, 38–40
fixedParameters, 43
fixedParametersPreequilibration, 43
my, 41
mz, 42
nmaxevent, 43
nt, 43
nytrue, 42
nztrue, 42
setObservedData, 40
setObservedDataStdDev, 40
setObservedEvents, 41
setObservedEventsStdDev, 41
sigmay, 42
sigmaz, 42
amici::ForwardProblem
∼ForwardProblem, 45
edata, 52
ForwardProblem, 44
getDJydx, 49
getDJzdx, 49
getDiscontinuities, 48
getNumberOfRoots, 48
getRHSAtDiscontinuities, 47
getRHSBeforeDiscontinuities, 48
getRootCounter, 49
getRootIndexes, 48
getStateDerivativePointer, 50
getStateDerivativeSensitivityPointer, 51
getStatePointer, 50
getStateSensitivity, 47
getStateSensitivityPointer, 51
getStatesAtDiscontinuities, 47
getTime, 46
model, 52
rdata, 52
solver, 52
workForwardProblem, 45
amici::IDAException
IDAException, 53
amici::IntegrationFailure
error_code, 55
IntegrationFailure, 55
time, 55
amici::Model
∼Model, 63
boost::serialization::serialize, 143
checkFinite, 118
clone, 63
dJrzdsigma, 151

dJrzdz, 151
dJydp, 148
dJydsigma, 150
dJydy, 150
dJzdp, 148
dJzdsigma, 151
dJzdz, 150
deltaqB, 149
deltasx, 149
deltax, 148
deltaxB, 149
drzdp, 152
drzdx, 152
dsigmaydp, 147
dsigmazdp, 148
dwdp, 153
dwdx, 153
dxdotdp, 149
dydp, 152
dydx, 152
dzdp, 151
dzdx, 151
fJDiag, 66
fJSparse, 66
fJrz, 86, 132
fJv, 68
fJy, 84, 131
fJz, 85, 131
fdJrzdsigma, 91, 135
fdJrzdz, 90, 134
fdJydp, 93
fdJydsigma, 88, 133
fdJydx, 94
fdJydy, 86, 132
fdJzdp, 95
fdJzdsigma, 89, 134
fdJzdx, 96
fdJzdz, 89, 133
fdeltaqB, 82, 128
fdeltasx, 80, 127
fdeltax, 79, 126
fdeltaxB, 81, 128
fdrzdp, 78, 125
fdrzdx, 79, 126
fdsigma_ydp, 83, 129
fdsigma_zdp, 84, 130
fdwdp, 114, 135
fdwdx, 115, 136
fdx0, 69
fdxdotdp, 67
fdydp, 72, 121
fdydx, 73, 121
fdzdp, 77, 124
fdzdx, 78, 125
fixedParameters, 154
fJ, 65
froot, 64
frz, 75, 123
fsJy, 92
fsJz, 94
fsdx0, 71
fsigma_y, 83, 129
fsigma_z, 83, 130
fsrz, 76, 124
fstau, 71, 120
fsx0, 70, 119
fsy, 91
fsz, 74, 122
fsz_tf, 92
fw, 113, 135
fx0, 69, 119
fxdot, 65
fy, 72, 121
fz, 74, 122
getFixedParameters, 105
getInitialStateSensitivities, 110
getInitialStates, 109
getParameterList, 108
getParameterScale, 103
getParameters, 104
getSolver, 64
getTimepoints, 106
getUnscaledParameters, 105
getmy, 136
getmz, 137
getrz, 141
getsrz, 142
getsx, 140
getsz, 142
gett, 118
getx, 139
gety, 138
getz, 140
h, 153
idlist, 147
initHeaviside, 98
initialize, 96
initializeStates, 97
J, 149
k, 101
lbw, 146
M, 153
Model, 61–63
my, 150
mz, 150
nMaxEvent, 102
ndwdp, 146
ndwdx, 145
ne, 145
nJ, 146
nk, 101
nmaxevent, 155
nnz, 146
np, 100
nplist, 99
nt, 102

nw, 145
nx, 144
nxtrue, 144
ny, 144
nytrue, 144
nz, 145
nztrue, 145
o2mode, 147
operator=, 63
operator==, 143
originalParameters, 154
plist, 112
plist_, 154
pscale, 155
setFixedParameters, 105
setInitialStateSensitivities, 110
setInitialStates, 109
setNMaxEvent, 102
setParameterList, 109
setParameterScale, 103
setParameters, 104
setT0, 111
setTimepoints, 106
sigmay, 147
sigmaz, 148
stau, 153
sx0data, 155
t, 107
t0, 110
ts, 155
tstart, 155
ubw, 146
unscaleParameters, 112
unscaledParameters, 154
updateHeaviside, 117
updateHeavisideB, 118
w, 152
x0data, 154
z2event, 147
amici::Model_DAE
fJDiag, 164, 178
fJSparse, 161, 162, 177
fJSparseB, 163, 177
fJB, 160, 176
fJv, 164, 165, 179
fJvB, 166, 179
fdxdotdp, 172, 173, 182
fJ, 159, 160, 175
fM, 174, 184
fqBdot, 171, 182
froot, 167, 168, 180
fsxdot, 173, 183
fxBdot, 170, 181
fxdot, 169, 170, 181
getSolver, 175
Model_DAE, 157
amici::Model_ODE
fJDiag, 193, 194, 207
fJSparse, 190, 191, 206
fJSparseB, 192, 206
fJB, 190, 205
fJv, 195, 196, 207
fJvB, 196, 208
fdxdotdp, 202, 203, 211
fJ, 188, 189, 204
fqBdot, 201, 210
froot, 197, 198, 208
fsxdot, 203, 211
fxBdot, 200, 209
fxdot, 199, 209
getSolver, 204
Model_ODE, 186, 187
amici::NewtonFailure
NewtonFailure, 213
amici::NewtonSolver
atol, 218
dx, 220
getSensis, 216
getSolver, 214
getStep, 215
maxlinsteps, 218
maxsteps, 218
model, 219
NewtonSolver, 214
prepareLinearSystem, 217
rdata, 219
rtol, 218
solveLinearSystem, 217
t, 219
x, 219
xdot, 219
amici::NewtonSolverDense
NewtonSolverDense, 221
prepareLinearSystem, 222
solveLinearSystem, 221
amici::NewtonSolverIterative
linsolveSPBCG, 225
NewtonSolverIterative, 223
prepareLinearSystem, 225
solveLinearSystem, 224
amici::NewtonSolverSparse
NewtonSolverSparse, 227
prepareLinearSystem, 228
solveLinearSystem, 228
amici::ReturnData
applyChainRuleFactorToSimulationResults, 232
boost::serialization::serialize, 233
chi2, 240
invalidate, 231
invalidateLLH, 232
J, 233
llh, 239
ne, 242
newton_maxsteps, 243
newton_numlinsteps, 239
newton_numsteps, 239

newton_status, 238
newton_time, 238
nJ, 242
nk, 241
nmaxevent, 243
np, 240
nplist, 242
nt, 243
numerrtestfails, 237
numerrtestfailsB, 237
numnonlinsolvconvfails, 238
numnonlinsolvconvfailsB, 238
numrhsevals, 237
numrhsevalsB, 237
numsteps, 236
numstepsB, 237
nx, 241
nxtrue, 241
ny, 241
nytrue, 241
nz, 242
nztrue, 242
o2mode, 243
order, 238
pscale, 243
res, 236
ReturnData, 231
rz, 234
s2llh, 240
s2rz, 235
sensi, 244
sensi_meth, 244
sigmay, 235
sigmaz, 234
sllh, 240
sres, 236
srz, 234
ssigmay, 236
ssigmaz, 234
status, 240
sx, 235
sx0, 239
sy, 236
sz, 234
ts, 233
x, 235
x0, 239
xdot, 233
y, 235
z, 233
amici::SetupFailure
SetupFailure, 274
amici::Solver
AMIAdjInit, 316
AMIBand, 319
AMIBandB, 320
AMICalcICB, 287
AMICalcIC, 286
AMICreate, 308
AMICreateB, 317
AMIDense, 318
AMIDenseB, 319
AMIDiag, 320
AMIDiagB, 321
AMIFree, 316
AMIGetAdjBmem, 329
AMIGetDky, 315
AMIGetLastOrder, 328
AMIGetNumErrTestFails, 327
AMIGetNumNonlinSolvConvFails, 328
AMIGetNumRhsEvals, 327
AMIGetNumSteps, 326
AMIGetQuadB, 291
AMIGetRootInfo, 285
AMIGetSens, 283
AMIGetB, 290
AMIKLUSetOrdering, 325
AMIKLUSetOrderingB, 325
AMIKLUB, 326
AMIKLU, 324
AMIQuadReInitB, 292
AMIQuadSStolerancesB, 318
AMIReInit, 285
AMIReInitB, 290
AMISStolerances, 309
AMISStolerancesB, 317
AMISensReInit, 286
AMISensSStolerances, 309
AMISetErrHandlerFn, 311
AMISetId, 314
AMISetMaxNumSteps, 312
AMISetMaxNumStepsB, 312
AMISetQuadErrConB, 310
AMISetSensErrCon, 310
AMISetSensParams, 315
AMISetStabLimDet, 313
AMISetStabLimDetB, 313
AMISetStopTime, 289
AMISetSuppressAlg, 314
AMISetUserData, 311
AMISetUserDataB, 312
AMISolve, 287
AMISolveB, 289
AMISolveF, 288
AMISpbcg, 322
AMISpbcgB, 323
AMISpgmr, 321
AMISpgmrB, 322
AMISptfqmr, 323
AMISptfqmrB, 324
ami_mem, 334
binit, 303
boost::serialization::serialize, 334
clone, 279
getAbsoluteTolerance, 296
getAbsoluteToleranceQuadratures, 297

getDiagnosis, 283
getDiagnosisB, 284
getInternalSensitivityMethod, 302
getInterpolationType, 299
getLinearMultistepMethod, 298
getLinearSolver, 301
getMaxSteps, 297
getMaxStepsBackwardProblem, 298
getNewtonMaxLinearSteps, 294
getNewtonMaxSteps, 293
getNewtonPreequilibration, 294
getNonlinearSolverIteration, 299
getRelativeTolerance, 295
getRelativeToleranceQuadratures, 296
getSensitivityMethod, 293
getSensitivityOrder, 295
getStabilityLimitFlag, 301
getStateOrdering, 300
init, 302
initializeLinearSolver, 330
initializeLinearSolverB, 332
operator==, 334
qbinit, 303
rootInit, 304
sensInit1, 304
setAbsoluteTolerance, 296
setAbsoluteToleranceQuadratures, 297
setBandJacFn, 305
setBandJacFnB, 307
setDenseJacFn, 305
setDenseJacFnB, 306
setInternalSensitivityMethod, 302
setInterpolationType, 300
setJacTimesVecFn, 306
setJacTimesVecFnB, 307
setLinearMultistepMethod, 299
setLinearSolver, 301
setMaxSteps, 298
setMaxStepsBackwardProblem, 298
setNewtonMaxLinearSteps, 295
setNewtonMaxSteps, 293
setNewtonPreequilibration, 294
setNonlinearSolverIteration, 299
setRelativeTolerance, 296
setRelativeToleranceQuadratures, 297
setSensitivityMethod, 293
setSensitivityOrder, 295
setSparseJacFn, 305
setSparseJacFnB, 306
setStabilityLimitFlag, 301
setStateOrdering, 300
setupAMIB, 281
setupAMI, 279
Solver, 278
solverWasCalled, 335
turnOffRootFinding, 292
wrapErrHandlerFn, 308
amici::SteadystateProblem
applyNewtonsMethod, 337
getNewtonOutput, 338
getNewtonSimulation, 338
SteadystateProblem, 335
workSteadyStateProblem, 336
amici::sbml_import::SbmlImporter
__init__, 248
checkSupport, 253
cleanReservedSymbols, 257
compileCCode, 264
computeModelEquations, 259
computeModelEquationsAdjointSensitivites, 262
computeModelEquationsForwardSensitivites, 262
computeModelEquationsLinearSolver, 260
computeModelEquationsObjectiveFunction, 261
computeModelEquationsSensitivitesCore, 261
generateCCode, 263
getFunctionBody, 266
getSparseSymLines, 271
getSparseSymbols, 258
getSymLines, 270
loadSBMLFile, 248
prepareModelFolder, 263
printWithException, 272
processCompartments, 254
processParameters, 253
processReactions, 254
processRules, 255
processSBML, 251
processSpecies, 253
processTime, 256
processVolumeConversion, 255
replaceInAllExpressions, 256
replaceSpecialConstants, 258
sbml2amici, 249
setName, 250
setPaths, 251
writeCMakeFile, 268
writeFunctionFile, 265
writeIndexFiles, 265
writeModelHeader, 268
writeModuleSetup, 269
writeSwigFiles, 269
writeWrapfunctionsCPP, 267
writeWrapfunctionsHeader, 267
amidata, 339
amidata, 341
condition, 343
conditionPreequilibration, 344
ne, 342
nk, 342
nt, 341
ny, 341
nz, 341
Sigma_Y, 343
Sigma_Z, 343
t, 342
Y, 342

Z, 343
amievent, 344
amievent, 345
bolus, 346
hflag, 346
setHflag, 345
trigger, 346
z, 346
amifun, 347
amifun, 348
argstr, 353
cvar, 353
deps, 354
funstr, 353
gccode, 350
getArgs, 351
getCVar, 351
getDeps, 350
getNVecs, 351
getSensiFlag, 352
getSyms, 352
nvecs, 354
sensiflag, 354
strsym, 353
strsym_old, 353
sym, 352
sym_noopt, 352
writeCcode, 349
writeCcode_sensi, 348
writeMcode, 349
amimodel, 354
adjoint, 369
amimodel, 358
augmento2, 365
augmento2vec, 365
cfun, 376
checkDeps, 363
colptrs, 374
colptrsB, 374
compileAndLinkModel, 366
compileC, 360
coptim, 375
debug, 368
event, 368
forward, 369
fun, 367
funs, 375
generateMatlabWrapper, 366
generateC, 360
generateM, 360
getFun, 361
HTable, 368
id, 372
lbw, 373
loadOldHashes, 364
makeEvents, 362
makeSyms, 363
maxflag, 377
mfuns, 375
minflag, 377
modelname, 368
ndwdp, 378
ndwdx, 378
nevent, 371
ng, 371
nk, 371
nnz, 373
np, 371
nw, 377
nx, 370
nxtrue, 370
ny, 370
nytrue, 370
nz, 372
nztrue, 372
o2flag, 376
param, 375
parseModel, 359
recompile, 376
rowvals, 373
rowvalsB, 374
sparseidx, 373
sparseidxB, 374
splineflag, 377
sym, 367
t0, 369
ubw, 372
updateModelName, 359
updateRHS, 358
updateWrapPath, 359
wrap_path, 376
wtype, 369
z2event, 377
amioption, 378
amioption, 380
atol, 380
interpType, 383
ism, 383
iter, 382
linsol, 382
lmm, 382
maxsteps, 381
maxstepsB, 381
newton_maxlinsteps, 385
newton_maxsteps, 385
newton_preeq, 385
nmaxevent, 384
ordering, 384
pscale, 386
quad_atol, 381
quad_rtol, 381
rtol, 380
sens_ind, 381
sensi, 383
sensi_meth, 383
ss, 384

stldet, 382
sx0, 384
tstart, 382
x0, 384
z2event, 385
amised, 386
amised, 387
datasym, 389
model, 387
modelname, 388
outputcount, 388
sedml, 388
varidx, 388
varsym, 389
applyChainRuleFactorToSimulationResults
amici::ReturnData, 232
applyNewtonsMethod
amici::SteadystateProblem, 337
argstr
amifun, 353
at
amici::AmiVector, 23
amici::AmiVectorArray, 28
atol
amici::NewtonSolver, 218
amioption, 380
augmento2
amimodel, 365
augmento2vec
amimodel, 365

BackwardProblem, 31
amici::BackwardProblem, 31
binit
amici::Solver, 303
bolus
amievent, 346
boost::serialization::serialize
amici::Model, 143
amici::ReturnData, 233
amici::Solver, 334

cfun
amimodel, 376
checkDeps
amimodel, 363
checkFinite
amici::Model, 118
checkSupport
amici::sbml_import::SbmlImporter, 253
chi2
amici::ReturnData, 240
cleanReservedSymbols
amici::sbml_import::SbmlImporter, 257
clone
amici::Model, 63
amici::Solver, 279
colptrs
amimodel, 374
colptrsB
amimodel, 374
compileAndLinkModel
amimodel, 366
compileCCode
amici::sbml_import::SbmlImporter, 264
compileC
amimodel, 360
computeModelEquations
amici::sbml_import::SbmlImporter, 259
computeModelEquationsAdjointSensitivites
amici::sbml_import::SbmlImporter, 262
computeModelEquationsForwardSensitivites
amici::sbml_import::SbmlImporter, 262
computeModelEquationsLinearSolver
amici::sbml_import::SbmlImporter, 260
computeModelEquationsObjectiveFunction
amici::sbml_import::SbmlImporter, 261
computeModelEquationsSensitivitesCore
amici::sbml_import::SbmlImporter, 261
condition
amidata, 343
conditionPreequilibration
amidata, 344
coptim
amimodel, 375
cvar
amifun, 353
CvodeException, 37
amici::CvodeException, 37

dJrzdsigma
amici::Model, 151
dJrzdz
amici::Model, 151
dJydp
amici::Model, 148
dJydsigma
amici::Model, 150
dJydy
amici::Model, 150
dJzdp
amici::Model, 148
dJzdsigma
amici::Model, 151
dJzdz
amici::Model, 150
data
amici::AmiVector, 19, 20
amici::AmiVectorArray, 27
datasym
amised, 389
debug
amimodel, 368
deltaqB
amici::Model, 149
deltasx
amici::Model, 149
deltax

amici::Model, 148
deltaxB
amici::Model, 149
deps
amifun, 354
drzdp
amici::Model, 152
drzdx
amici::Model, 152
dsigmaydp
amici::Model, 147
dsigmazdp
amici::Model, 148
dwdp
amici::Model, 153
dwdx
amici::Model, 153
dx
amici::NewtonSolver, 220
dxdotdp
amici::Model, 149
dydp
amici::Model, 152
dydx
amici::Model, 152
dzdp
amici::Model, 151
dzdx
amici::Model, 151

edata
amici::ForwardProblem, 52
error_code
amici::IntegrationFailure, 55
event
amimodel, 368
ExpData, 38
amici::ExpData, 38–40

fJDiag
amici::Model, 66
amici::Model_DAE, 164, 178
amici::Model_ODE, 193, 194, 207
fJSparse
amici::Model, 66
amici::Model_DAE, 161, 162, 177
amici::Model_ODE, 190, 191, 206
fJSparseB
amici::Model_DAE, 163, 177
amici::Model_ODE, 192, 206
fJB
amici::Model_DAE, 160, 176
amici::Model_ODE, 190, 205
fJrz
amici::Model, 86, 132
fJv
amici::Model, 68
amici::Model_DAE, 164, 165, 179
amici::Model_ODE, 195, 196, 207
fJvB
amici::Model_DAE, 166, 179
amici::Model_ODE, 196, 208
fJy
amici::Model, 84, 131
fJz
amici::Model, 85, 131
fdJrzdsigma
amici::Model, 91, 135
fdJrzdz
amici::Model, 90, 134
fdJydp
amici::Model, 93
fdJydsigma
amici::Model, 88, 133
fdJydx
amici::Model, 94
fdJydy
amici::Model, 86, 132
fdJzdp
amici::Model, 95
fdJzdsigma
amici::Model, 89, 134
fdJzdx
amici::Model, 96
fdJzdz
amici::Model, 89, 133
fdeltaqB
amici::Model, 82, 128
fdeltasx
amici::Model, 80, 127
fdeltax
amici::Model, 79, 126
fdeltaxB
amici::Model, 81, 128
fdrzdp
amici::Model, 78, 125
fdrzdx
amici::Model, 79, 126
fdsigma_ydp
amici::Model, 83, 129
fdsigma_zdp
amici::Model, 84, 130
fdwdp
amici::Model, 114, 135
fdwdx
amici::Model, 115, 136
fdx0
amici::Model, 69
fdxdotdp
amici::Model, 67
amici::Model_DAE, 172, 173, 182
amici::Model_ODE, 202, 203, 211
fdydp
amici::Model, 72, 121
fdydx
amici::Model, 73, 121
fdzdp

amici::Model, 77, 124
fdzdx
amici::Model, 78, 125
fixedParameters
amici::ExpData, 43
amici::Model, 154
fixedParametersPreequilibration
amici::ExpData, 43
fJ
amici::Model, 65
amici::Model_DAE, 159, 160, 175
amici::Model_ODE, 188, 189, 204
fM
amici::Model_DAE, 174, 184
forward
amimodel, 369
ForwardProblem, 43
amici::ForwardProblem, 44
fqBdot
amici::Model_DAE, 171, 182
amici::Model_ODE, 201, 210
froot
amici::Model, 64
amici::Model_DAE, 167, 168, 180
amici::Model_ODE, 197, 198, 208
frz
amici::Model, 75, 123
fsJy
amici::Model, 92
fsJz
amici::Model, 94
fsdx0
amici::Model, 71
fsigma_y
amici::Model, 83, 129
fsigma_z
amici::Model, 83, 130
fsrz
amici::Model, 76, 124
fstau
amici::Model, 71, 120
fsx0
amici::Model, 70, 119
fsxdot
amici::Model_DAE, 173, 183
amici::Model_ODE, 203, 211
fsy
amici::Model, 91
fsz
amici::Model, 74, 122
fsz_tf
amici::Model, 92
fun
amimodel, 367
funs
amimodel, 375
funstr
amifun, 353
fw
amici::Model, 113, 135
fx0
amici::Model, 69, 119
fxBdot
amici::Model_DAE, 170, 181
amici::Model_ODE, 200, 209
fxdot
amici::Model, 65
amici::Model_DAE, 169, 170, 181
amici::Model_ODE, 199, 209
fy
amici::Model, 72, 121
fz
amici::Model, 74, 122

gccode
amifun, 350
generateCCode
amici::sbml_import::SbmlImporter, 263
generateMatlabWrapper
amimodel, 366
generateC
amimodel, 360
generateM
amimodel, 360
getAbsoluteTolerance
amici::Solver, 296
getAbsoluteToleranceQuadratures
amici::Solver, 297
getArgs
amifun, 351
getBacktrace
amici::AmiException, 15
getCVar
amifun, 351
getDJydx
amici::ForwardProblem, 49
getDJzdx
amici::ForwardProblem, 49
getDeps
amifun, 350
getDiagnosis
amici::Solver, 283
getDiagnosisB
amici::Solver, 284
getDiscontinuities
amici::ForwardProblem, 48
getFixedParameters
amici::Model, 105
getFun
amimodel, 361
getFunctionBody
amici::sbml_import::SbmlImporter, 266
getInitialStateSensitivities
amici::Model, 110
getInitialStates
amici::Model, 109
getInternalSensitivityMethod

amici::Solver, 302
getInterpolationType
amici::Solver, 299
getLength
amici::AmiVector, 21
amici::AmiVectorArray, 30
getLinearMultistepMethod
amici::Solver, 298
getLinearSolver
amici::Solver, 301
getMaxSteps
amici::Solver, 297
getMaxStepsBackwardProblem
amici::Solver, 298
getNVecs
amifun, 351
getNVector
amici::AmiVector, 20
amici::AmiVectorArray, 29
getNVectorArray
amici::AmiVectorArray, 28
getNewtonMaxLinearSteps
amici::Solver, 294
getNewtonMaxSteps
amici::Solver, 293
getNewtonOutput
amici::SteadystateProblem, 338
getNewtonPreequilibration
amici::Solver, 294
getNewtonSimulation
amici::SteadystateProblem, 338
getNonlinearSolverIteration
amici::Solver, 299
getNumberOfRoots
amici::ForwardProblem, 48
getParameterList
amici::Model, 108
getParameterScale
amici::Model, 103
getParameters
amici::Model, 104
getRHSAtDiscontinuities
amici::ForwardProblem, 47
getRHSBeforeDiscontinuities
amici::ForwardProblem, 48
getRelativeTolerance
amici::Solver, 295
getRelativeToleranceQuadratures
amici::Solver, 296
getRootCounter
amici::ForwardProblem, 49
getRootIndexes
amici::ForwardProblem, 48
getSensiFlag
amifun, 352
getSensis
amici::NewtonSolver, 216
getSensitivityMethod
amici::Solver, 293
getSensitivityOrder
amici::Solver, 295
getSolver
amici::Model, 64
amici::Model_DAE, 175
amici::Model_ODE, 204
amici::NewtonSolver, 214
getSparseSymLines
amici::sbml_import::SbmlImporter, 271
getSparseSymbols
amici::sbml_import::SbmlImporter, 258
getStabilityLimitFlag
amici::Solver, 301
getStateDerivativePointer
amici::ForwardProblem, 50
getStateDerivativeSensitivityPointer
amici::ForwardProblem, 51
getStateOrdering
amici::Solver, 300
getStatePointer
amici::ForwardProblem, 50
getStateSensitivity
amici::ForwardProblem, 47
getStateSensitivityPointer
amici::ForwardProblem, 51
getStatesAtDiscontinuities
amici::ForwardProblem, 47
getStep
amici::NewtonSolver, 215
getSymLines
amici::sbml_import::SbmlImporter, 270
getSyms
amifun, 352
getTime
amici::ForwardProblem, 46
getTimepoints
amici::Model, 106
getUnscaledParameters
amici::Model, 105
getVector
amici::AmiVector, 21
getdJydx
amici::BackwardProblem, 36
getdxBptr
amici::BackwardProblem, 35
getmy
amici::Model, 136
getmz
amici::Model, 137
getoptimized
optsym, 390
getrz
amici::Model, 141
getsrz
amici::Model, 142
getsx
amici::Model, 140

getsz
amici::Model, 142
gett
amici::BackwardProblem, 33
amici::Model, 118
getwhich
amici::BackwardProblem, 34
getwhichptr
amici::BackwardProblem, 34
getx
amici::Model, 139
getxBptr
amici::BackwardProblem, 34
getxQBptr
amici::BackwardProblem, 35
gety
amici::Model, 138
getz
amici::Model, 140

h
amici::Model, 153
HTable
amimodel, 368
hflag
amievent, 346

IDAException, 53
amici::IDAException, 53
id
amimodel, 372
idlist
amici::Model, 147
init
amici::Solver, 302
initHeaviside
amici::Model, 98
initialize
amici::Model, 96
initializeLinearSolver
amici::Solver, 330
initializeLinearSolverB
amici::Solver, 332
initializeStates
amici::Model, 97
IntegrationFailure, 54
amici::IntegrationFailure, 55
interpType
amioption, 383
invalidate
amici::ReturnData, 231
invalidateLLH
amici::ReturnData, 232
ism
amioption, 383
iter
amioption, 382

J
amici::Model, 149
amici::ReturnData, 233

k
amici::Model, 101

lbw
amici::Model, 146
amimodel, 373
linsol
amioption, 382
linsolveSPBCG
amici::NewtonSolverIterative, 225
llh
amici::ReturnData, 239
lmm
amioption, 382
loadOldHashes
amimodel, 364
loadSBMLFile
amici::sbml_import::SbmlImporter, 248

M
amici::Model, 153
makeEvents
amimodel, 362
makeSyms
amimodel, 363
maxflag
amimodel, 377
maxlinsteps
amici::NewtonSolver, 218
maxsteps
amici::NewtonSolver, 218
amioption, 381
maxstepsB
amioption, 381
mfuns
amimodel, 375
minflag
amimodel, 377
minus
amici::AmiVector, 22
Model, 56
amici::Model, 61–63
model
amici::ForwardProblem, 52
amici::NewtonSolver, 219
amised, 387
Model_DAE, 156
amici::Model_DAE, 157
Model_ODE, 184
amici::Model_ODE, 186, 187
modelname
amimodel, 368
amised, 388
my
amici::ExpData, 41
amici::Model, 150

mz
amici::ExpData, 42
amici::Model, 150

nMaxEvent
amici::Model, 102
ndwdp
amici::Model, 146
amimodel, 378
ndwdx
amici::Model, 145
amimodel, 378
ne
amici::Model, 145
amici::ReturnData, 242
amidata, 342
nevent
amimodel, 371
newton_maxlinsteps
amioption, 385
newton_maxsteps
amici::ReturnData, 243
amioption, 385
newton_numlinsteps
amici::ReturnData, 239
newton_numsteps
amici::ReturnData, 239
newton_preeq
amioption, 385
newton_status
amici::ReturnData, 238
newton_time
amici::ReturnData, 238
NewtonFailure, 212
amici::NewtonFailure, 213
NewtonSolver, 213
amici::NewtonSolver, 214
NewtonSolverDense, 220
amici::NewtonSolverDense, 221
NewtonSolverIterative, 223
amici::NewtonSolverIterative, 223
NewtonSolverSparse, 227
amici::NewtonSolverSparse, 227
ng
amimodel, 371
nJ
amici::Model, 146
amici::ReturnData, 242
nk
amici::Model, 101
amici::ReturnData, 241
amidata, 342
amimodel, 371
nmaxevent
amici::ExpData, 43
amici::Model, 155
amici::ReturnData, 243
amioption, 384
nnz
amici::Model, 146
amimodel, 373
np
amici::Model, 100
amici::ReturnData, 240
amimodel, 371
nplist
amici::Model, 99
amici::ReturnData, 242
nt
amici::ExpData, 43
amici::Model, 102
amici::ReturnData, 243
amidata, 341
numerrtestfails
amici::ReturnData, 237
numerrtestfailsB
amici::ReturnData, 237
numnonlinsolvconvfails
amici::ReturnData, 238
numnonlinsolvconvfailsB
amici::ReturnData, 238
numrhsevals
amici::ReturnData, 237
numrhsevalsB
amici::ReturnData, 237
numsteps
amici::ReturnData, 236
numstepsB
amici::ReturnData, 237
nvecs
amifun, 354
nw
amici::Model, 145
amimodel, 377
nx
amici::Model, 144
amici::ReturnData, 241
amimodel, 370
nxtrue
amici::Model, 144
amici::ReturnData, 241
amimodel, 370
ny
amici::Model, 144
amici::ReturnData, 241
amidata, 341
amimodel, 370
nytrue
amici::ExpData, 42
amici::Model, 144
amici::ReturnData, 241
amimodel, 370
nz
amici::Model, 145
amici::ReturnData, 242
amidata, 341
amimodel, 372

nztrue
amici::ExpData, 42
amici::Model, 145
amici::ReturnData, 242
amimodel, 372

o2flag
amimodel, 376
o2mode
amici::Model, 147
amici::ReturnData, 243
operator=
amici::AmiVector, 18
amici::Model, 63
operator==
amici::Model, 143
amici::Solver, 334
operator[]
amici::AmiVector, 23
amici::AmiVectorArray, 29
optsym, 389
getoptimized, 390
optsym, 390
order
amici::ReturnData, 238
ordering
amioption, 384
originalParameters
amici::Model, 154
outputcount
amised, 388

param
amimodel, 375
parseModel
amimodel, 359
plist
amici::Model, 112
plist_
amici::Model, 154
prepareLinearSystem
amici::NewtonSolver, 217
amici::NewtonSolverDense, 222
amici::NewtonSolverIterative, 225
amici::NewtonSolverSparse, 228
prepareModelFolder
amici::sbml_import::SbmlImporter, 263
printWithException
amici::sbml_import::SbmlImporter, 272
processCompartments
amici::sbml_import::SbmlImporter, 254
processParameters
amici::sbml_import::SbmlImporter, 253
processReactions
amici::sbml_import::SbmlImporter, 254
processRules
amici::sbml_import::SbmlImporter, 255
processSBML
amici::sbml_import::SbmlImporter, 251
processSpecies
amici::sbml_import::SbmlImporter, 253
processTime
amici::sbml_import::SbmlImporter, 256
processVolumeConversion
amici::sbml_import::SbmlImporter, 255
pscale
amici::Model, 155
amici::ReturnData, 243
amioption, 386

qbinit
amici::Solver, 303
quad_atol
amioption, 381
quad_rtol
amioption, 381

rdata
amici::ForwardProblem, 52
amici::NewtonSolver, 219
recompile
amimodel, 376
replaceInAllExpressions
amici::sbml_import::SbmlImporter, 256
replaceSpecialConstants
amici::sbml_import::SbmlImporter, 258
res
amici::ReturnData, 236
reset
amici::AmiVector, 22
amici::AmiVectorArray, 30
ReturnData, 229
amici::ReturnData, 231
rootInit
amici::Solver, 304
rowvals
amimodel, 373
rowvalsB
amimodel, 374
rtol
amici::NewtonSolver, 218
amioption, 380
rz
amici::ReturnData, 234

s2llh
amici::ReturnData, 240
s2rz
amici::ReturnData, 235
SBMLException, 244
sbml2amici
amici::sbml_import::SbmlImporter, 249
SbmlImporter, 245
sedml
amised, 388
sens_ind
amioption, 381
sensInit1

amici::Solver, 304
sensi
amici::ReturnData, 244
amioption, 383
sensi_meth
amici::ReturnData, 244
amioption, 383
sensiflag
amifun, 354
set
amici::AmiVector, 22
setAbsoluteTolerance
amici::Solver, 296
setAbsoluteToleranceQuadratures
amici::Solver, 297
setBandJacFn
amici::Solver, 305
setBandJacFnB
amici::Solver, 307
setDenseJacFn
amici::Solver, 305
setDenseJacFnB
amici::Solver, 306
setFixedParameters
amici::Model, 105
setHflag
amievent, 345
setInitialStateSensitivities
amici::Model, 110
setInitialStates
amici::Model, 109
setInternalSensitivityMethod
amici::Solver, 302
setInterpolationType
amici::Solver, 300
setJacTimesVecFn
amici::Solver, 306
setJacTimesVecFnB
amici::Solver, 307
setLinearMultistepMethod
amici::Solver, 299
setLinearSolver
amici::Solver, 301
setMaxSteps
amici::Solver, 298
setMaxStepsBackwardProblem
amici::Solver, 298
setNMaxEvent
amici::Model, 102
setName
amici::sbml_import::SbmlImporter, 250
setNewtonMaxLinearSteps
amici::Solver, 295
setNewtonMaxSteps
amici::Solver, 293
setNewtonPreequilibration
amici::Solver, 294
setNonlinearSolverIteration
amici::Solver, 299
setObservedData
amici::ExpData, 40
setObservedDataStdDev
amici::ExpData, 40
setObservedEvents
amici::ExpData, 41
setObservedEventsStdDev
amici::ExpData, 41
setParameterList
amici::Model, 109
setParameterScale
amici::Model, 103
setParameters
amici::Model, 104
setPaths
amici::sbml_import::SbmlImporter, 251
setRelativeTolerance
amici::Solver, 296
setRelativeToleranceQuadratures
amici::Solver, 297
setSensitivityMethod
amici::Solver, 293
setSensitivityOrder
amici::Solver, 295
setSparseJacFn
amici::Solver, 305
setSparseJacFnB
amici::Solver, 306
setStabilityLimitFlag
amici::Solver, 301
setStateOrdering
amici::Solver, 300
setT0
amici::Model, 111
setTimepoints
amici::Model, 106
setupAMIB
amici::Solver, 281
setupAMI
amici::Solver, 279
SetupFailure, 273
amici::SetupFailure, 274
Sigma_Y
amidata, 343
Sigma_Z
amidata, 343
sigmay
amici::ExpData, 42
amici::Model, 147
amici::ReturnData, 235
sigmaz
amici::ExpData, 42
amici::Model, 148
amici::ReturnData, 234
sllh
amici::ReturnData, 240
solveLinearSystem

amici::NewtonSolver, 217
amici::NewtonSolverDense, 221
amici::NewtonSolverIterative, 224
amici::NewtonSolverSparse, 228
Solver, 275
amici::Solver, 278
solver
amici::ForwardProblem, 52
solverWasCalled
amici::Solver, 335
sparseidx
amimodel, 373
sparseidxB
amimodel, 374
splineflag
amimodel, 377
sres
amici::ReturnData, 236
srz
amici::ReturnData, 234
ss
amioption, 384
ssigmay
amici::ReturnData, 236
ssigmaz
amici::ReturnData, 234
status
amici::ReturnData, 240
stau
amici::Model, 153
SteadystateProblem, 335
amici::SteadystateProblem, 335
stldet
amioption, 382
storeBacktrace
amici::AmiException, 16
strsym
amifun, 353
strsym_old
amifun, 353
sx
amici::ReturnData, 235
sx0
amici::ReturnData, 239
amioption, 384
sx0data
amici::Model, 155
sy
amici::ReturnData, 236
sym
amifun, 352
amimodel, 367
sym_noopt
amifun, 352
sz
amici::ReturnData, 234

t
amici::Model, 107
amici::NewtonSolver, 219
amidata, 342
t0
amici::Model, 110
amimodel, 369
TemplateAmici, 272
time
amici::IntegrationFailure, 55
trigger
amievent, 346
ts
amici::Model, 155
amici::ReturnData, 233
tstart
amici::Model, 155
amioption, 382
turnOffRootFinding
amici::Solver, 292

ubw
amici::Model, 146
amimodel, 372
unscaleParameters
amici::Model, 112
unscaledParameters
amici::Model, 154
updateHeaviside
amici::Model, 117
updateHeavisideB
amici::Model, 118
updateModelName
amimodel, 359
updateRHS
amimodel, 358
updateWrapPath
amimodel, 359

varidx
amised, 388
varsym
amised, 389

w
amici::Model, 152
what
amici::AmiException, 15
workBackwardProblem
amici::BackwardProblem, 32
workForwardProblem
amici::ForwardProblem, 45
workSteadyStateProblem
amici::SteadystateProblem, 336
wrap_path
amimodel, 376
wrapErrHandlerFn
amici::Solver, 308
writeCMakeFile
amici::sbml_import::SbmlImporter, 268
writeCcode

amifun, 349
writeCcode_sensi
amifun, 348
writeFunctionFile
amici::sbml_import::SbmlImporter, 265
writeIndexFiles
amici::sbml_import::SbmlImporter, 265
writeMcode
amifun, 349
writeModelHeader
amici::sbml_import::SbmlImporter, 268
writeModuleSetup
amici::sbml_import::SbmlImporter, 269
writeSwigFiles
amici::sbml_import::SbmlImporter, 269
writeWrapfunctionsCPP
amici::sbml_import::SbmlImporter, 267
writeWrapfunctionsHeader
amici::sbml_import::SbmlImporter, 267
wtype
amimodel, 369

x
amici::NewtonSolver, 219
amici::ReturnData, 235
x0
amici::ReturnData, 239
amioption, 384
x0data
amici::Model, 154
xdot
amici::NewtonSolver, 219
amici::ReturnData, 233

Y
amidata, 342
y
amici::ReturnData, 235

Z
amidata, 343
z
amici::ReturnData, 233
amievent, 346
z2event
amici::Model, 147
amimodel, 377
amioption, 385