Unit Test Documentation

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May 9, 2016

Contents

Part I

Unit Test Library

Chapter 1

Introduction

The UnitTest library contains classes which preform automated unit tests while a project is under development. Utilizing C++ exceptions, the UnitTest library separates its test battery into libraries tested, suites in libraries and tests in suites. The UnitTest library iterates through instantiated libraries running every test suite in the library.

1.1 Namespace test

The test namespace is designed to hold all of the classes and functions related to unit testing. Classes and functions in the test namespace should not be included in the final release application. It is expected that libraries add to this namespace and place their own testing assets here. Note that the test namespace uses elements from the os namespace, all of these elements are defined in the Datastructures library.

1.2 Datastructures Testing

The Datastructures library is rigorously unit tested by the UnitTest library, and the Datastructures unit tests are automatically included in any system unit test unless specifically removed. The Datastructures UnitTests are particularly important because the Datastructures library serves as a base for memory management and data organization. These tests fall broadly into two categories: deterministic and random.

Deterministic tests preform the exact same test every iteration. Deterministic tests are used to ensure that specific functions and operators are returning expected data. Deterministic tests don't merely identify the existence of an error, but usually identify the precise nature of the error as well.

Random tests use a random number generator to preform a unique test with every iteration. This allows unit tests to, over time, catch edge cases with complex data structures. In contrast to deterministic tests, random testing will usually not identify the precise nature of the error.

Note that as a general rule, the implementation of tests is not documented. The location of test suites is documented, through both .h and .cpp files, but the classes and functions which make up these tests are not included.

Chapter 2

File Index

2.1 File List

Here is a list of all files with brief descriptions:

Chapter 3

File Documentation

3.1 DatastructuresTest.h File Reference

Datastructures library test.

3.1.1 Detailed Description

Datastructures library test.

Author

Jonathan Bedard

Date

2/4/2016

Bug No known bugs.

Contains the declaration of the Datastructures library test. Note that this library test is automatically added to all Unit Test executables.

3.2 DatastructuresTest.cpp File Reference

Datastructures library test implementation.

3.2.1 Detailed Description

Datastructures library test implementation.

Author

Jonathan Bedard

Date

4/18/2016

Bug No known bugs.

Implements the Datastructures library test. These tests are designed to guarantee the functionality of each of the elements in the Datastructures library.

3.3 masterTestHolder.h File Reference

Library tests, masterTestHolder singleton.

Classes

- class **test::libraryTests**

  Library test group.
- class **test::masterTestHolder**

  Unit Test singleton.

Namespaces

- **test**

3.3.1 Detailed Description

Library tests, masterTestHolder singleton.
Jonathan Bedard

Date

4/11/2016

Bug No known bugs.

This file contains declarations for the library test base class and **test::masterTestHolder** (p. 25) singleton class. This file represents the top level of the Unit Test driver classes.

3.4 masterTestHolder.cpp File Reference

Library tests, masterTestHolder singleton implementations.

3.4.1 Detailed Description

Library tests, masterTestHolder singleton implementations.
Jonathan Bedard

Date

4/11/2016

Bug No known bugs.

This file contains implementations for the library test base class and **test::masterTestHolder** (p. 25) singleton class. Consult **masterTestHolder.h** (p. 6) for details.

3.5 singleTest.h File Reference

Single test class.

Classes

- class **test::singleTest**
  Single unit test class.
- class **test::singleFunctionTest**
  Single unit test from function.

Namespaces

- **test**

Typedefs

- typedef void(∗ **test::testFunction**) ()
  Typedef for single test function.

3.5.1 Detailed Description

Single test class.
Jonathan Bedard

Date

2/6/2016

Bug No known bugs.

This file contains declarations for a single unit test. Unit tests can be defined as separate class or a simple test function.

3.6 singleTest.cpp File Reference

Single test class implementation.

3.6.1 Detailed Description

Single test class implementation.
Jonathan Bedard

Date

2/6/2016

Bug No known bugs.

This file contains implementation for a single unit test. Consult singeTest.h for details.

3.7 TestSuite.h File Reference

Single test class.

Classes

- class **test::testSuite**

Namespaces

- **test**

3.7.1 Detailed Description

Single test class.
Jonathan Bedard

Date

4/11/2016

Bug No known bugs.

This file contains declarations for a test suite. Test suites contain lists of unit tests.

3.8 TestSuite.cpp File Reference

Single test class.

3.8.1 Detailed Description

Single test class.
Jonathan Bedard

Date

2/12/2016

Bug No known bugs.

This file contains declarations for a test suite. Consult **testSuite.h** (p. 8) for details.

3.9 UnitTest.h File Reference

Unit Test header file.

Namespaces

- **test**

Functions

- void **test::startTests** ()

  Print out header for Unit Tests.
- void **test::endTestsError** (os::smart_ptr< std::exception > except)

  End tests in error.
- void **test::endTestsSuccess** ()

  End tests successfully.
- void **test::testInit** (int argc=0, char **argv=NULL)

  Test initialization.

3.9.1 Detailed Description

Unit Test header file.

Author

Jonathan Bedard

Date

4/2/2016

Bug No known bugs.

Packages all headers required for the UnitTest library and declares a number of global test functions used for initializing and ending a Unit Test battery.

3.10 UnitTest.cpp File Reference

Unit Test logging and global functions.

3.10.1 Detailed Description

Unit Test logging and global functions.

Author

Jonathan Bedard

Date

2/4/2016

Bug No known bugs.

Implements logging in the test namespace. Implements a number of global test functions used for initializing and ending a Unit Test battery.

3.11 UnitTestLog.h File Reference

Namespaces

- **test**

Functions

- std::ostream & **test::testout_func** ()

  Standard out object for test namespace.
- std::ostream & **test::testerr_func** ()

  Standard error object for test namespace.

Variables

- os::smart_ptr< std::ostream > **test::testout_ptr**

  Standard out pointer for test namespace.
- os::smart_ptr< std::ostream > **test::testerr_ptr**

  Standard error pointer for test namespace.

3.12 UnitTestExceptions.h File Reference

Common exceptions thrown by unit tests.

Classes

- class **test::generalTestException**

  Base class for test exceptions.
- class **test::unknownException**

  Unknown exception class.
- class **test::nullFunctionException**

  NULL function exception class.

Namespaces

- **test**

3.12.1 Detailed Description

Common exceptions thrown by unit tests.

Jonathan Bedard

Date

2/19/2016

Bug No known bugs.

This file contains a number of common test exceptions used by unit tests. All of these classes extend std::exception.

Chapter 4

Class Index

4.1 Class List

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

Chapter 5

Namespace Documentation

5.1 test Namespace Reference

Classes

- class **generalTestException**
  Base class for test exceptions.
- class **libraryTests**
  Library test group.
- class **masterTestHolder**
  Unit Test singleton.
- class **nullFunctionException**
  NULL function exception class.
- class **singleFunctionTest**
  Single unit test from function.
- class **singleTest**
  Single unit test class.
- class **testSuite**
- class **unknownException**
  Unknown exception class.

Typedefs

- typedef void(∗ **testFunction**) ()
  Typedef for single test function.

Functions

- void **startTests** ()
  Print out header for Unit Tests.
- void **endTestsError** (os::smart_ptr< std::exception > except)
  End tests in error.

- void **endTestsSuccess** ()

  End tests successfully.
- void **testInit** (int argc=0, char **argv=NULL)

  Test initialization.
- std::ostream & **testout_func** ()

  Standard out object for test namespace.
- std::ostream & **testerr_func** ()

  Standard error object for test namespace.

Variables

- os::smart_ptr< std::ostream > **testout_ptr**

  Standard out pointer for test namespace.
- os::smart_ptr< std::ostream > **testerr_ptr**

  Standard error pointer for test namespace.

5.1.1 Typedef Documentation

typedef void(* test::testFunction) ()

Typedef for single test function.

This typedef defines what a single test function looks like. For simplicity, a single unit test can be defined by a function of this type instead of inheriting from **test::singleTest** (p. 30).

Returns

void

5.1.2 Function Documentation

void test::endTestsError (os::smart_ptr< std::exception > except)

End tests in error.

Prints out a global division block line of '=' characters, then the information provided in the exception passed to the function then another global division block

Parameters

in	*except*	Exception which caused the error

Returns

void

void test::endTestsSuccess ( )

End tests successfully.

Prints out a global division block line of '=' characters, then the test results data provided by the **test::masterTestHolder** (p. 25) then another global division block

Returns

void

void test::startTests ( )

Print out header for Unit Tests.

Prints out a global division block line of '=' characters, then 'Unit Test Battery' and then another global division block.

Returns

void

std::ostream& test::testerr_func ( )

Standard error object for test namespace.

#define statements allow the user to call this function with "test::testerr." Logging is achieved by using "test::testerr" as one would use "std::cerr."

void test::testInit (int argc = 0, char ** argv = NULL)

Test initialization.

This function is re-implemented by each executable which uses the UnitTest library. This function is used to bind all of the library tests, except the Datastructures library test.

Returns

void

std::ostream& test::testout_func ( )

Standard out object for test namespace.

#define statements allow the user to call this function with "test::testout." Logging is achieved by using "test::testout" as one would use "std::cout."

5.1.3 Variable Documentation

os::smart_ptr<std::ostream> test::testerr_ptr

Standard error pointer for test namespace.

This std::ostream is used as standard error for the test namespace. This pointer can be swapped out to programmatically redirect standard error for the test namespace.

os::smart_ptr<std::ostream> test::testout_ptr

Standard out pointer for test namespace.

This std::ostream is used as standard out for the test namespace. This pointer can be swapped out to programmatically redirect standard out for the test namespace.

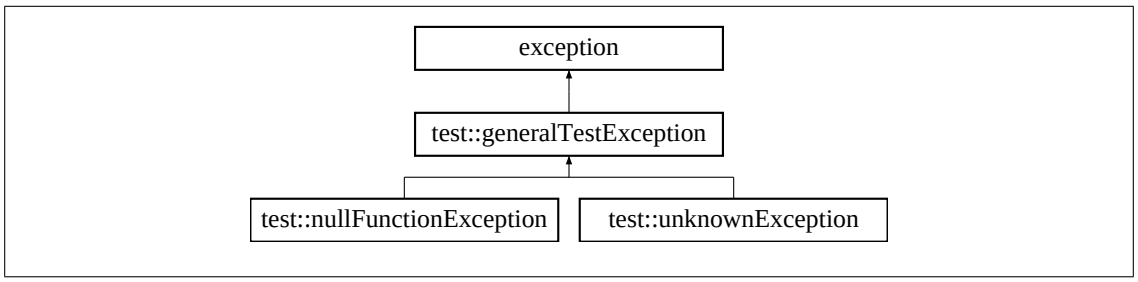
Chapter 6

Class Documentation

6.1 test::generalTestException Class Reference

Base class for test exceptions.

Inheritance diagram for test::generalTestException:



Public Member Functions

- **generalTestException** (std::string err, std::string loc)

  Construct exception with error and location.
- virtual ~**generalTestException** () throw ()

  Virtual destructor.
- virtual const char * **what** () const throw ()

  std::exception overload
- const std::string & **getLocation** () const

  Location description.
- const std::string & **getString** () const

  Error description.

Private Attributes

- std::string **location**

  The location where the error came from.

- std::string **_error**

  A description of the error.
- std::string **total_error**

  Combination of the error and location.

6.1.1 Detailed Description

Base class for test exceptions.

This class defines an exception which has a location. Because this class holds multiple std::string objects, the error description can be dynamically set.

6.1.2 Constructor & Destructor Documentation

test::generalTestException::generalTestException (std::string err, std::string loc) `[inline]`

Construct exception with error and location.

Constructs the exception with an error string and a location string. Also builds the **test::general↩ TestException::total_error** (p. 18) string for use by the "what()" function.

Parameters

`in`	*err*	Error string
`in`	*loc*	Location string

virtual test::generalTestException::~generalTestException ( ) throw) `[inline]`, `[virtual]`

Virtual destructor.

Destructor must be virtual, if an object of this type is deleted, the destructor of the type which inherits this class should be called.

6.1.3 Member Function Documentation

const std::string& test::generalTestException::getLocation ( ) const `[inline]`

Location description.

Returns

test::generalTestException::location (p. 18)

const std::string& test::generalTestException::getString ( ) const `[inline]`

Error description.

Returns

test::generalTestException::_error (p. 18)

virtual const char* test::generalTestException::what ( ) const throw) [inline], [virtual]

std::exception overload

Overloaded from std::exception. This function outputs the complete description, which contains both the error description and location description.

Returns

character pointer to the complete description

6.1.4 Member Data Documentation

std::string test::generalTestException::_error [private]

A description of the error.

std::string test::generalTestException::location [private]

The location where the error came from.

std::string test::generalTestException::total_error [private]

Combination of the error and location.

This string is constructed in the constructor so that "what()" can refer to a location in memory. This std::string is a combination of **test::generalTestException::_error** (p. 18) and **test::general↩ TestException::location** (p. 18).

6.2 test::libraryTests Class Reference

Library test group.

Public Member Functions

- **libraryTests** (std::string ln)

  Library test constructor.
- virtual ~**libraryTests** ()

  Virtual destructor.
- void **runTests** () throw (os::smart_ptr<std::exception>)

  Runs all of the test suites.
- virtual void **onSetup** ()

  Runs on shutdown of the group.
- virtual void **onTeardown** ()

  Runs on teardown of the group.
- void **logBegin** ()

  Logs the beginning of a library test.
- bool **logEnd** (os::smart_ptr< std::exception > except=NULL)

  Logs the end of a library test.

- int **getNumSuites** () const

  Number of suites in the set.
- int **getNumSuccess** () const

  Number of suites successfully completed.
- int **getNumRun** () const

  Number of suites attempted to run.
- void **pushSuite** (os::smart_ptr< **testSuite** > suite)

  Add suite to the set.
- void **removeSuite** (os::smart_ptr< **testSuite** > suite)

  Remove suite from the set.
- bool **operator==** (const **libraryTests** &lt) const

  Equality comparison.
- bool **operator!=** (const **libraryTests** &lt) const

  Not-equals comparison.
- bool **operator**> (const **libraryTests** &lt) const

  Greater-than comparison.
- bool **operator**< (const **libraryTests** &lt) const

  Less-than comparison.
- bool **operator**>**=** (const **libraryTests** &lt) const

  Greater-than or equal to comparison.
- bool **operator**<**=** (const **libraryTests** &lt) const

  Less-than or equal to comparison.

Private Attributes

- std::string **libName**

  Name of library to be tested.
- os::smartSet< **testSuite** > **suiteList**

  Set of test suites.
- int **suitesCompleted**

  Number of suites successfully completed.
- int **suitesRun**

  Number of suites attempted to run.

6.2.1 Detailed Description

Library test group.

This class contains a set of test suites which are designed to a specific library. Each library must define it's own version of this class in-order to be tested.

6.2.2 Constructor & Destructor Documentation

test::libraryTests::libraryTests (std::string ln)

Library test constructor.

This constructor initializes the number of suites completed and number of suites run to 0, along with sets the name of library being tested.

Parameters

in	*ln*	Name of library to be tested

virtual test::libraryTests::~libraryTests ( ) [inline], [virtual]

Virtual destructor.

Destructor must be virtual, if an object of this type is deleted, the destructor of the type which inherits this class should be called.

6.2.3 Member Function Documentation

int test::libraryTests::getNumRun ( ) const [inline]

Number of suites attempted to run.

Returns

test::libraryTests::suitesRun (p. 25)

int test::libraryTests::getNumSuccess ( ) const [inline]

Number of suites successfully completed.

Returns

test::libraryTests::suitesCompleted (p. 25)

int test::libraryTests::getNumSuites ( ) const [inline]

Number of suites in the set.

Returns

test::libraryTests::suiteList.size()

void test::libraryTests::logBegin ( )

Logs the beginning of a library test.

Outputs the name of the library to be tested along with a line break made of '+' characters.

Returns

void

bool test::libraryTests::logEnd (os::smart_ptr< std::exception > except = NULL)

Logs the end of a library test.

Outputs the number of suites run and how many of these suites were both successful and how many of these suites failed.

Returns

True if all suites successful, else false

virtual void test::libraryTests::onSetup ( ) [inline], [virtual]

Runs on shutdown of the group.

Each library group calls this funciton as it starts up, allowing groups to define actions performed to setup the group.

Returns

void

virtual void test::libraryTests::onTeardown ( ) [inline], [virtual]

Runs on teardown of the group.

Guranteed to run even if the group itself fails. A custom tear-down for the group can re-impliment this class.

Returns

void

bool test::libraryTests::operator!= (const **libraryTests** & lt) const [inline]

Not-equals comparison.

Compares two test::libraryTest based on the library name. If the two names are not-equal, the library tests are not-equal.

Parameters

in	*lt*	Reference to test::libraryTest to be compared against

Returns

this->libName!=lt.libName

bool test::libraryTests::operator< (const **libraryTests** & lt) const [inline]

Less-than comparison.

Compares two test::libraryTest based on the library name. If the name of this object is less than the name of the reference object, return true.

Parameters

in	*lt*	Reference to test::libraryTest to be compared against

Returns

this->libName<lt.libName

bool test::libraryTests::operator<= (const **libraryTests** & lt) const [inline]

Less-than or equal to comparison.

Compares two test::libraryTest based on the library name. If the name of this object is less than or equal to the name of the reference object, return true.

Parameters

in	*lt*	Reference to test::libraryTest to be compared against

Returns

this->libName<=lt.libName

bool test::libraryTests::operator== (const **libraryTests** & lt) const [inline]

Equality comparison.

Compares two test::libraryTest based on the library name. If the two names are equal, the library tests are equal.

Parameters

in	*lt*	Reference to test::libraryTest to be compared against

Returns

this->libName==lt.libName

bool test::libraryTests::operator> (const **libraryTests** & lt) const [inline]

Greater-than comparison.

Compares two test::libraryTest based on the library name. If the name of this object is greater than the name of the reference object, return true.

Parameters

in	*lt*	Reference to test::libraryTest to be compared against

Returns

this->libName>lt.libName

bool test::libraryTests::operator>= (const **libraryTests** & lt) const [inline]

Greater-than or equal to comparison.

Compares two test::libraryTest based on the library name. If the name of this object is greater than or equal to the name of the reference object, return true.

Parameters

in	*lt*	Reference to test::libraryTest to be compared against

Returns

this->libName>=lt.libName

void test::libraryTests::pushSuite (os::smart_ptr< **testSuite** > suite) [inline]

Add suite to the set.

Adds a **test::testSuite** (p. 33) to the set of suites to be tested.

Parameters

in	*suite*	Test suite to be added to set

Returns

void

void test::libraryTests::removeSuite (os::smart_ptr< **testSuite** > suite) [inline]

Remove suite from the set.

Removes a **test::testSuite** (p. 33) from the set of suites to be tested.

Parameters

in	*suite*	Test suite to be removed from the set

Returns

void

void test::libraryTests::runTests ( ) throw os::smart_ptr< std::exception >)

Runs all of the test suites.

Runs all test suites bound to this class. Each suite should manage its own errors, but it is possible that this function will throw an error of type os::smart_ptr<std::exception>.

Returns

void

6.2.4 Member Data Documentation

std::string test::libraryTests::libName [private]

Name of library to be tested.

os::smartSet<**testSuite**> test::libraryTests::suiteList [private]

Set of test suites.

int test::libraryTests::suitesCompleted [private]

Number of suites successfully completed.

int test::libraryTests::suitesRun [private]

Number of suites attempted to run.

6.3 test::masterTestHolder Class Reference

Unit Test singleton.

Public Member Functions

- virtual ~**masterTestHolder** ()
  Virtual destructor.
- bool **runTests** () throw (os::smart_ptr<std::exception>)
  Runs all of the library tests.
- int **getNumLibs** () const
  Number of libraries in the set.
- int **getNumSuccess** () const
  Number of libraries successfully completed.
- int **getNumRun** () const
  Number of libraries attempted to run.
- void **pushLibrary** (os::smart_ptr< **libraryTests** > lib)
  Add library to the set.
- void **removeLibrary** (os::smart_ptr< **libraryTests** > lib)
  Remove library from the set.

Static Public Member Functions

- static os::smart_ptr< **masterTestHolder** > **singleton** ()
  Singleton access.

Private Member Functions

- **masterTestHolder** ()
  Private constructor.

Private Attributes

- os::smartSet< **libraryTests** > **libraryList**

  Set of library tests.
- int **libsCompleted**

  Number of libraries successfully completed.
- int **libsRun**

  Number of libraries attempted to run.

6.3.1 Detailed Description

Unit Test singleton.

This class contains a set of library tests. Every library test must add itself to this class in-order to be tested. The **test::masterTestHolder::runTests()** (p. 27) function runs all of the library tests.

6.3.2 Constructor & Destructor Documentation

test::masterTestHolder::masterTestHolder ( ) `[private]`

Private constructor.

The **test::masterTestHolder** (p. 25) class is a singleton class. This constructor initializes the number of libraries completed and number of libraries run to 0.

virtual test::masterTestHolder::~masterTestHolder ( ) `[inline]`, `[virtual]`

Virtual destructor.

Destructor must be virtual, if an object of this type is deleted, the destructor of the type which inherits this class should be called.

6.3.3 Member Function Documentation

int test::masterTestHolder::getNumLibs ( ) const `[inline]`

Number of libraries in the set.

Returns

test::masterTestHolder::libraryList.size()

int test::masterTestHolder::getNumRun ( ) const `[inline]`

Number of libraries attempted to run.

Returns

test::masterTestHolder::libsRun (p. 28)

int test::masterTestHolder::getNumSuccess ( ) const [inline]

Number of libraries successfully completed.

Returns

test::masterTestHolder::libsCompleted (p. 28)

void test::masterTestHolder::pushLibrary (os::smart_ptr< **libraryTests** > lib) [inline]

Add library to the set.

Adds a **test::libraryTests** (p. 18) to the set of library tests to be tested.

Parameters

in	*lib*	Library test to be added to set

Returns

void

void test::masterTestHolder::removeLibrary (os::smart_ptr< **libraryTests** > lib) [inline]

Remove library from the set.

Removes a **test::libraryTests** (p. 18) from the set of library tests to be tested.

Parameters

in	*lib*	Library test to be removed from the set

Returns

void

bool test::masterTestHolder::runTests ( ) throw os::smart_ptr< std::exception >)

Runs all of the library tests.

Runs all library tests bound to this class. Each library should manage its own errors, but it is possible that this function will throw an error of type os::smart_ptr<std::exception>.

Returns

True if all the tests were successful, else, false

static os::smart_ptr<**masterTestHolder**> test::masterTestHolder::singleton ( ) [static]

Singleton access.

This function constructs the single reference to the **test::masterTestHolder** (p. 25) class if needed. Then, it returns a pointer to this single reference.

Returns

Singleton reference to **test::masterTestHolder** (p. 25)

6.3.4 Member Data Documentation

os::smartSet<**libraryTests**> test::masterTestHolder::libraryList `[private]`

Set of library tests.

int test::masterTestHolder::libsCompleted `[private]`

Number of libraries successfully completed.

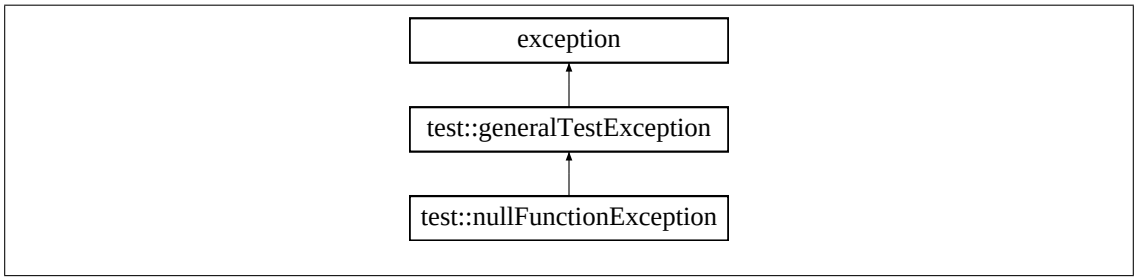
int test::masterTestHolder::libsRun `[private]`

Number of libraries attempted to run.

6.4 test::nullFunctionException Class Reference

NULL function exception class.

Inheritance diagram for test::nullFunctionException:



Public Member Functions

- **nullFunctionException** (std::string loc)

  Construct exception with location.
- virtual ~**nullFunctionException** () throw ()

  Virtual destructor.

6.4.1 Detailed Description

NULL function exception class.

This class defines the common exception case where a NULL function pointer is received.

6.4.2 Constructor & Destructor Documentation

test::nullFunctionException::nullFunctionException (std::string loc) `[inline]`

Construct exception with location.

Constructs a **test::generalTestException** (p. 16) with the provided location and the static string for a NULL function exception.

Parameters

`in`	*loc*	Location string

virtual test::nullFunctionException::~nullFunctionException ( ) throw) `[inline]`, `[virtual]`

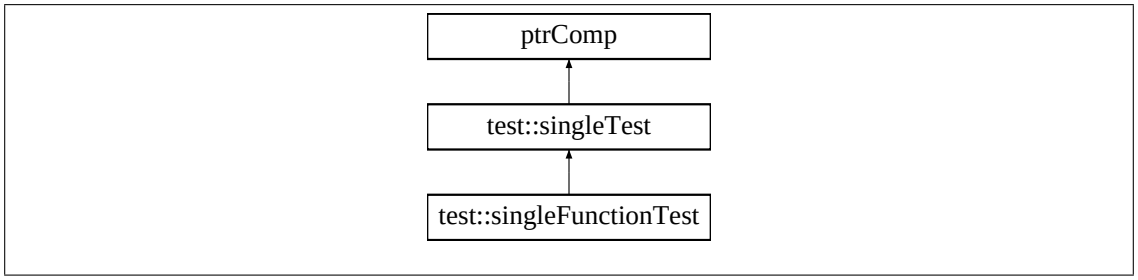
Virtual destructor.

Destructor must be virtual, if an object of this type is deleted, the destructor of the type which inherits this class should be called.

6.5 test::singleFunctionTest Class Reference

Single unit test from function.

Inheritance diagram for test::singleFunctionTest:



Public Member Functions

- **singleFunctionTest** (std::string tn, **testFunction** f)

  Single unit test constructor.
- virtual ~**singleFunctionTest** ()

  Virtual destructor.
- void **test** () throw (os::smart_ptr<std::exception>)

  Call unit test function.

Private Attributes

- **testFunction func**

  Reference to unit test function.

6.5.1 Detailed Description

Single unit test from function.

This class allows a **test::singleTest** (p. 30) to be defined by a single test function.

6.5.2 Constructor & Destructor Documentation

test::singleFunctionTest::singleFunctionTest (std::string tn, **testFunction** f)

Single unit test constructor.

Parameters

in	*tn*	Name of unit test
in	*f*	Function which defines test

virtual test::singleFunctionTest::~singleFunctionTest ( ) [inline], [virtual]

Virtual destructor.

Destructor must be virtual, if an object of this type is deleted, the destructor of the type which inherits this class should be called.

6.5.3 Member Function Documentation

void test::singleFunctionTest::test ( ) throw os::smart_ptr< std::exception >) [virtual]

Call unit test function.

Calls the function bound to this class in the constructor pointed to by **test::singleFunctionTest↩ ::func** (p. 30). If the function pointed to by the function pointer throws an exception, this function will throw the same exception.

Returns

void

Reimplemented from **test::singleTest** (p. 33).

6.5.4 Member Data Documentation

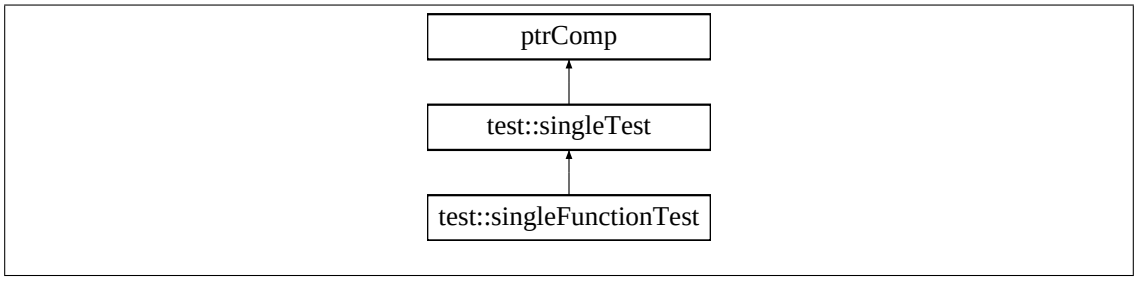
testFunction test::singleFunctionTest::func [private]

Reference to unit test function.

6.6 test::singleTest Class Reference

Single unit test class.

Inheritance diagram for test::singleTest:



Public Member Functions

- **singleTest** (std::string tn)

  Single unit test constructor.
- virtual ~**singleTest** ()

  Virtual destructor.
- virtual void **setupTest** () throw (os::smart_ptr<std::exception>)

  Preforms any test set-up.
- virtual void **test** () throw (os::smart_ptr<std::exception>)

  Preforms core unit-test.
- virtual void **teardownTest** () throw (os::smart_ptr<std::exception>)

  Preforms any test tear-down.
- void **logBegin** ()

  Prints out the name of the test.
- bool **logEnd** (os::smart_ptr< std::exception > except=NULL)

  Logs errors for test.

Private Attributes

- std::string **testName**

  Name of unit test.

6.6.1 Detailed Description

Single unit test class.

This class acts as the base class for all unit tests. It inherits from the os::ptrComp class to allow it to be inserted into abstract data-structures.

6.6.2 Constructor & Destructor Documentation

test::singleTest::singleTest (std::string tn)

Single unit test constructor.

Parameters

in	*tn*	Name of unit test

virtual test::singleTest::~singleTest ( ) [inline], [virtual]

Virtual destructor.

Destructor must be virtual, if an object of this type is deleted, the destructor of the type which inherits this class should be called.

6.6.3 Member Function Documentation

void test::singleTest::logBegin ( )

Prints out the name of the test.

Returns

void

bool test::singleTest::logEnd (os::smart_ptr< std::exception > except = NULL)

Logs errors for test.

If the passed exception is NULL, no logging is preformed. Otherwise, the "what()" function of the exception is printed. This function return true if NULL is passed as the exception.

Parameters

in	*except*	Exception to be printed, NULL by default

Returns

True if except is NULL

virtual void test::singleTest::setupTest ( ) throw os::smart_ptr< std::exception >) [inline], [virtual]

Preforms any test set-up.

This function is designed to preform any set-up a test requires. This is especially useful if a class of tests require the same set-up routine. This function assumes that the **test::testSuite** (p. 33) will catch exceptions in this function if they are thrown.

Returns

void

virtual void test::singleTest::teardownTest ( ) throw os::smart_ptr< std::exception >) [inline], [virtual]

Preforms any test tear-down.

This function is designed to preform any tear-down a test requires. This is especially useful if a class of tests require the same tear-down routine. This function assumes that the **test::testSuite** (p. 33) will catch exceptions in this function if they are thrown.

Returns

void

virtual void test::singleTest::test ( ) throw os::smart_ptr< std::exception >) [virtual]

Preforms core unit-test.

This function is designed to preform the actual unit test. This function assumes that the **test::testSuite** (p. 33) will catch exceptions in this function if they are thrown.

Returns

void

Reimplemented in **test::singleFunctionTest** (p. 30).

6.6.4 Member Data Documentation

std::string test::singleTest::testName [private]

Name of unit test.

6.7 test::testSuite Class Reference

Public Member Functions

- **testSuite** (std::string sn)
  Test suite constructor.
- virtual ~**testSuite** ()
  Virtual destructor.
- void **runTests** () throw (os::smart_ptr<std::exception>)
  Runs all of the tests.
- virtual void **onSetup** ()
  Runs on shutdown.
- virtual void **onTeardown** ()
  Runs on teardown of the suite.
- void **logBegin** ()
  Logs the beginning of a suite test.
- bool **logEnd** (os::smart_ptr< std::exception > except=NULL)
  Logs the end of a suite test.
- int **getNumTests** () const
  Number of tests in the set.
- int **getNumSuccess** () const
  Number of tests successfully completed.
- int **getNumRun** () const
  Number of tests attempted to run.
- void **pushTest** (os::smart_ptr< **singleTest** > tst)

Add test to the set.

- void **removeTest** (os::smart_ptr< **singleTest** > tst)

  Remove test to the set.
- virtual void **pushTest** (std::string str, **testFunction** tst)

  Add test to the set.
- bool **operator==** (const **testSuite** &lt) const

  Equality comparison.
- bool **operator!=** (const **testSuite** &lt) const

  Not-equals comparison.
- bool **operator**> (const **testSuite** &lt) const

  Greater-than comparison.
- bool **operator**< (const **testSuite** &lt) const

  Less-than comparison.
- bool **operator**>**=** (const **testSuite** &lt) const

  Greater-than or equal to comparison.
- bool **operator**<**=** (const **testSuite** &lt) const

  Less-than or equal to comparison.

Private Attributes

- std::string **suiteName**

  Name of test suite.
- os::smartSet< **singleTest** > **testList**

  Set of tests.
- int **testsCompleted**

  Number of tests successfully completed.
- int **testsRun**

  Number of tests attempted to run.

6.7.1 Constructor & Destructor Documentation

test::testSuite::testSuite (std::string sn)

Test suite constructor.

This constructor initializes the number of tests completed and number of tests run to 0, along with sets the name of suite being tested.

Parameters

in	*sn*	Name of suite to be tested

virtual test::testSuite::~testSuite ( ) [inline], [virtual]

Virtual destructor.

Destructor must be virtual, if an object of this type is deleted, the destructor of the type which inherits this class should be called.

6.7.2 Member Function Documentation

int test::testSuite::getNumRun ( ) const [inline]

Number of tests attempted to run.

Returns

test::testSuite::testsRun (p. 39)

int test::testSuite::getNumSuccess ( ) const [inline]

Number of tests successfully completed.

Returns

test::testSuite::testsCompleted (p. 39)

int test::testSuite::getNumTests ( ) const [inline]

Number of tests in the set.

Returns

test::testSuite::testList.size()

void test::testSuite::logBegin ( )

Logs the beginning of a suite test.

Outputs the name of the suite to be tested along with a line break made of '-' characters.

Returns

void

bool test::testSuite::logEnd (os::smart_ptr< std::exception > except = NULL)

Logs the end of a suite test.

Outputs the number of tests run and how many of these tests were both successful and how many of these tests failed.

Returns

True if all tests successful, else false

virtual void test::testSuite::onSetup ( ) [inline], [virtual]

Runs on shutdown.

Each suite calls this funciton as it starts up, allowing suites to define actions performed to setup the suite.

Returns

void

virtual void test::testSuite::onTeardown ( ) [inline], [virtual]

Runs on teardown of the suite.

Guranteed to run even if the suite itself fails. A custom tear-down for the suite can re-impliment this class.

Returns

void

bool test::testSuite::operator!= (const **testSuite** & lt) const [inline]

Not-equals comparison.

Compares two **test::testSuite** (p. 33) based on the library name. If the two names are not-equal, the suites are not-equal.

Parameters

in	*lt*	Reference to **test::testSuite** (p. 33) to be compared against

Returns

this->suiteName!=lt.suiteName

bool test::testSuite::operator< (const **testSuite** & lt) const [inline]

Less-than comparison.

Compares two **test::testSuite** (p. 33) based on the library name. If the name of this object is less than the name of the reference object, return true.

Parameters

in	*lt*	Reference to **test::testSuite** (p. 33) to be compared against

Returns

this->suiteName<lt.suiteName

bool test::testSuite::operator<= (const **testSuite** & lt) const [inline]

Less-than or equal to comparison.

Compares two **test::testSuite** (p. 33) based on the library name. If the name of this object is less than or equal to the name of the reference object, return true.

Parameters

in	*lt*	Reference to **test::testSuite** (p. 33) to be compared against

Returns

this->suiteName<=lt.suiteName

bool test::testSuite::operator== (const **testSuite** & lt) const [inline]

Equality comparison.

Compares two **test::testSuite** (p. 33) based on the suite name. If the two names are equal, the suites are equal.

Parameters

in	*lt*	Reference to **test::testSuite** (p. 33) to be compared against

Returns

this->suiteName==lt.suiteName

bool test::testSuite::operator> (const **testSuite** & lt) const [inline]

Greater-than comparison.

Compares two **test::testSuite** (p. 33) based on the library name. If the name of this object is greater than the name of the reference object, return true.

Parameters

in	*lt*	Reference to **test::testSuite** (p. 33) to be compared against

Returns

this->suiteName>lt.suiteName

bool test::testSuite::operator>= (const **testSuite** & lt) const [inline]

Greater-than or equal to comparison.

Compares two **test::testSuite** (p. 33) based on the library name. If the name of this object is greater than or equal to the name of the reference object, return true.

Parameters

in	*lt*	Reference to **test::testSuite** (p. 33) to be compared against

Returns

this->suiteName>=lt.suiteName

void test::testSuite::pushTest (os::smart_ptr< **singleTest** > tst) [inline]

Add test to the set.

Adds a **test::singleTest** (p. 30) to the set of tests to be tested.

Parameters

in	*tst*	Test to be added to set

Returns

void

virtual void test::testSuite::pushTest (std::string str, **testFunction** tst) [inline], [virtual]

Add test to the set.

Adds a **test::testFunction** (p. 14) to the set of tests to be tested. Constructs a **test::singleTest** (p. 30) from a function and a test name

Parameters

in	*str*	Test name
in	*tst*	Function which defines test

Returns

void

void test::testSuite::removeTest (os::smart_ptr< **singleTest** > tst) [inline]

Remove test to the set.

Removes a **test::singleTest** (p. 30) from the set of tests to be tested.

Parameters

in	*tst*	Test to be removed from the set

Returns

void

void test::testSuite::runTests ( ) throw os::smart_ptr< std::exception >)

Runs all of the tests.

Runs all tests bound to this class. This function catches exceptions thrown by **test::singleTest** (p. 30) and logs the results.

Returns

void

6.7.3 Member Data Documentation

std::string test::testSuite::suiteName `[private]`

Name of test suite.

os::smartSet<**singleTest**> test::testSuite::testList `[private]`

Set of tests.

int test::testSuite::testsCompleted `[private]`

Number of tests successfully completed.

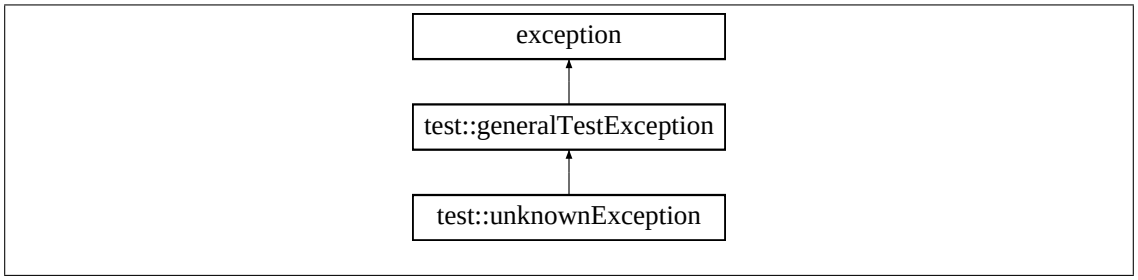
int test::testSuite::testsRun `[private]`

Number of tests attempted to run.

6.8 test::unknownException Class Reference

Unknown exception class.

Inheritance diagram for test::unknownException:



Public Member Functions

- **unknownException** (std::string loc)

  Construct exception with location.
- virtual ~**unknownException** () throw ()

  Virtual destructor.

6.8.1 Detailed Description

Unknown exception class.

This class defines the common exception case where the precise nature of the exception is unknown.

6.8.2 Constructor & Destructor Documentation

test::unknownException::unknownException (std::string loc) `[inline]`

Construct exception with location.

Constructs a **test::generalTestException** (p. 16) with the provided location and the static string for an unknown exception.

Parameters

`in`	*loc*	Location string

virtual test::unknownException::~unknownException ( ) throw) `[inline]`, `[virtual]`

Virtual destructor.

Destructor must be virtual, if an object of this type is deleted, the destructor of the type which inherits this class should be called.

Part II

Datastructures Library

Chapter 7

Introduction

The Datastructures library contains a series of utility classes and template classes used for the organization and management of data. Most notably, this library allow dynamic memory management through the smart_ptr class and provides a flexible runtime data container in the ads (Abstract Data Structure) template and its children.

7.1 Unit Testing

The testing of the Datastructures library is preformed within the UnitTest library. Since the UnitTest library uses the functionality of the Datastructures library, the Datastructures library cannot be dependent on the UnitTest library as the UnitTest library is already dependent on the Datastructures library

7.2 Namespace os

Datastructures extends the os namespace. The os namespace is designed for tools, algorithms and data-structures used in programs of all types. Structures in this library do not implement operating system specific interfaces such as sockets and file I/O. The osMechanics library also extends the os namespace.

Chapter 8

File Index

8.1 File List

Here is a list of all files with brief descriptions:

Chapter 9

File Documentation

9.1 Datastructures.h File Reference

Master Datastructures header file.

9.1.1 Detailed Description

Master Datastructures header file.

Author

Jonathan Bedard

Date

2/14/2016

Bug No known bugs.

All of the headers in the Datastructures library are held in this file. When using the Datastructures library, it is expected that this header is included instead of the individual required headers.

9.2 abstractSorting.h File Reference

Template for sorting arrays.

Namespaces

- **os**

Functions

- template<class dataType >
  int **os::defaultCompareSort** (const dataType &v1, const dataType &v2)

  Basic compare.

- template<class dataType >
  int **os::pointerCompareSort** (smart_ptr< dataType > ptr1, smart_ptr< dataType > ptr2)

  Raw pointer compare.
- template<class dataType >
  void **os::quicksort** (dataType *arr, unsigned int length, int(*sort_comparison)(const dataType &, const dataType &)=&defaultCompareSort)

  Template quick-sort.
- template<class dataType >
  void **os::pointerQuicksort** (smart_ptr< smart_ptr< dataType > > arr, unsigned int length, int(*sort_comparison)(smart_ptr< dataType >, smart_ptr< dataType >)=&pointerCompare↩ Sort)

  Template for quick-sort, pointer version.

9.2.1 Detailed Description

Template for sorting arrays.

Author

Jonathan Bedard

Date

2/15/2016

Bug No known bugs.

This file contains a template class definition of an AVL tree and its nodes. This tree has insertion, search and deletion of O(log(n)) where n is the number of nodes in the tree. This tree is thread safe.

9.3 ads.h File Reference

Abstract datastructure interface.

Classes

- class **os::ptrComp**

  Pointer compare interface.
- class **os::adnode**< **dataType** >

  Abstract data-node.
- class **os::ads**< **dataType** >

  Abstract datastructure.

Namespaces

- **os**

9.3.1 Detailed Description

Abstract datastructure interface.

Author

Jonathan Bedard

Date

5/9/2016

Bug No known bugs.

This file contains definitions of a set of class interfaces used by abstract datastructures and classes interfacing with abstract datastructures.

9.4 asyncAVL.h File Reference

Asynchronous AVL tree.

Classes

- class **os::asyncAVLNode**< **dataType** >

  Node for usage in an asynchronous AVL tree.
- class **os::asyncAVLTree**< **dataType** >

  Asynchronous balanced binary search tree.

Namespaces

- **os**

9.4.1 Detailed Description

Asynchronous AVL tree.

Author

Jonathan Bedard

Date

5/9/2016

Bug No known bugs.

This file contains a template class definition of an AVL tree and its nodes. This tree has insertion, search and deletion of O(log(n)) where n is the number of nodes in the tree. This tree is thread safe.

9.5 AVL.h File Reference

AVL tree.

Classes

- class **os::AVLNode**< **dataType** >
  Node for usage in an AVL tree.
- class **os::AVLTree**< **dataType** >
  Balanced binary search tree.

Namespaces

- **os**

9.5.1 Detailed Description

AVL tree.

Author

Jonathan Bedard

Date

2/12/2016

Bug No known bugs.

This file contains a template class definition of an AVL tree and its nodes. This tree has insertion, search and deletion of O(log(n)) where n is the number of nodes in the tree. This tree is not thread safe.

9.6 eventDriver.h File Reference

Event sender and receiver.

Classes

- class **os::eventSender**< **receiverType** >
  Class which enables event sending.
- class **os::eventReceiver**< **senderType** >
  Class which enables event receiving.

Namespaces

- **os**

Variables

- std::recursive_mutex * **os::eventLock**

  Event processing mutex.

9.6.1 Detailed Description

Event sender and receiver.

Author

Jonathan Bedard

Date

5/9/2016

Bug No known bugs.

Both **os::eventReceiver** (p. 128) and **os::eventSender** (p. 131) are experimental classes and have not been tested or utilized.

9.7 eventDriver.cpp File Reference

Event driver implementation.

9.7.1 Detailed Description

Event driver implementation.

Author

Jonathan Bedard

Date

2/28/2016

Bug No known bugs.

This file implements **os::eventLock** (p. 89) for **os::eventSender** (p. 131) and **os::eventReceiver** (p. 128). These are experimental class and not yet used or tested

9.8 list.h File Reference

Doubly Linked List.

Classes

- class **os::unsortedListNode**< **dataType** >

  Node for usage in a linked list.
- class **os::unsortedList**< **dataType** >

  Unsorted linked list.

Namespaces

- **os**

9.8.1 Detailed Description

Doubly Linked List.

Author

Jonathan Bedard

Date

2/1/2016

Bug No known bugs.

This file contains a template class definition of a linked list and its nodes. This list has insertion, find and delete of O(n). The linked list provided is doubly linked, allowing for forward and backward traversal. This list is not thread safe.

9.9 matrix.h File Reference

Matrix templates.

Classes

- class **os::matrix**< **dataType** >

  Raw matrix.
- class **os::indirectMatrix**< **dataType** >

  Indirect matrix.

Namespaces

- **os**

Functions

- template<class dataType >
  bool **os::compareSize** (const matrix< dataType > &m1, const matrix< dataType > &m2)

  Compares the size of two matrices.
- template<class dataType >
  bool **os::compareSize** (const indirectMatrix< dataType > &m1, const matrix< dataType > &m2)

  Compares the size of two matrices.
- template<class dataType >
  bool **os::compareSize** (const matrix< dataType > &m1, const indirectMatrix< dataType > &m2)

Compares the size of two matrices.

- template<class dataType >
  bool **os::compareSize** (const indirectMatrix< dataType > &m1, const indirectMatrix< dataType > &m2)

  Compares the size of two matrices.
- template<class dataType >
  bool **os::testCross** (const matrix< dataType > &m1, const matrix< dataType > &m2)

  Tests if the cross-product is a legal operation.
- template<class dataType >
  bool **os::testCross** (const indirectMatrix< dataType > &m1, const matrix< dataType > &m2)

  Tests if the cross-product is a legal operation.
- template<class dataType >
  bool **os::testCross** (const matrix< dataType > &m1, const indirectMatrix< dataType > &m2)

  Tests if the cross-product is a legal operation.
- template<class dataType >
  bool **os::testCross** (const indirectMatrix< dataType > &m1, const indirectMatrix< dataType > &m2)

  Tests if the cross-product is a legal operation.
- template<class dataType >
  bool **operator==** (const **os::matrix**< dataType > &m1, const **os::matrix**< dataType > &m2)

  Test for equality.
- template<class dataType >
  bool **operator==** (const **os::indirectMatrix**< dataType > &m1, const **os::matrix**< dataType > &m2)

  Test for equality.
- template<class dataType >
  bool **operator==** (const **os::matrix**< dataType > &m1, const **os::indirectMatrix**< dataType > &m2)

  Test for equality.
- template<class dataType >
  bool **operator==** (const **os::indirectMatrix**< dataType > &m1, const **os::indirectMatrix**< data↩ Type > &m2)

  Test for equality.
- template<class dataType >
  bool **operator!=** (const **os::matrix**< dataType > &m1, const **os::matrix**< dataType > &m2)

  Test for inequality.
- template<class dataType >
  bool **operator!=** (const **os::indirectMatrix**< dataType > &m1, const **os::matrix**< dataType > &m2)

  Test for inequality.
- template<class dataType >
  bool **operator!=** (const **os::matrix**< dataType > &m1, const **os::indirectMatrix**< dataType > &m2)

  Test for inequality.

- template<class dataType >
  bool **operator!=** (const **os::indirectMatrix**< dataType > &m1, const **os::indirectMatrix**< data↩ Type > &m2)

  Test for inequality.
- template<class dataType >
  os::matrix< dataType > **operator+** (const **os::matrix**< dataType > &m1, const **os::matrix**< dataType > &m2)

  Addition.
- template<class dataType >
  os::matrix< dataType > **operator+** (const **os::indirectMatrix**< dataType > &m1, const **os**↩ **::matrix**< dataType > &m2)

  Addition.
- template<class dataType >
  os::matrix< dataType > **operator+** (const **os::matrix**< dataType > &m1, const **os::indirect**↩ **Matrix**< dataType > &m2)

  Addition.
- template<class dataType >
  os::indirectMatrix< dataType > **operator+** (const **os::indirectMatrix**< dataType > &m1, const **os::indirectMatrix**< dataType > &m2)

  Addition.
- template<class dataType >
  os::matrix< dataType > **operator-** (const **os::matrix**< dataType > &m1, const **os::matrix**< dataType > &m2)

  Subtraction.
- template<class dataType >
  os::matrix< dataType > **operator-** (const **os::indirectMatrix**< dataType > &m1, const **os**↩ **::matrix**< dataType > &m2)

  Subtraction.
- template<class dataType >
  os::matrix< dataType > **operator-** (const **os::matrix**< dataType > &m1, const **os::indirect**↩ **Matrix**< dataType > &m2)

  Subtraction.
- template<class dataType >
  os::indirectMatrix< dataType > **operator-** (const **os::indirectMatrix**< dataType > &m1, const **os::indirectMatrix**< dataType > &m2)

  Subtraction.
- template<class dataType >
  os::matrix< dataType > **operator**∗ (const **os::matrix**< dataType > &m1, const **os::matrix**< dataType > &m2)

  Cross-product.
- template<class dataType >
  os::matrix< dataType > **operator**∗ (const **os::indirectMatrix**< dataType > &m1, const **os**↩ **::matrix**< dataType > &m2)

  Cross-product.

- template<class dataType >
  os::matrix< dataType > **operator**∗ (const **os::matrix**< dataType > &m1, const **os::indirect**↩ **Matrix**< dataType > &m2)

  Cross-product.
- template<class dataType >
  os::indirectMatrix< dataType > **operator**∗ (const **os::indirectMatrix**< dataType > &m1, const **os::indirectMatrix**< dataType > &m2)

  Cross-product.
- template<class dataType >
  os::matrix< dataType > **operator**∗ (const dataType &d1, const **os::matrix**< dataType > &m1)

  Scalar multiplication.
- template<class dataType >
  os::matrix< dataType > **operator**∗ (const **os::matrix**< dataType > &m1, const dataType &d1)

  Scalar multiplication.
- template<class dataType >
  os::matrix< dataType > **operator**/ (const **os::matrix**< dataType > &m1, const dataType &d1)

  Scalar division.
- template<class dataType >
  os::indirectMatrix< dataType > **operator**∗ (const dataType &d1, const **os::indirectMatrix**< dataType > &m1)

  Scalar multiplication.
- template<class dataType >
  os::indirectMatrix< dataType > **operator**∗ (const **os::indirectMatrix**< dataType > &m1, const dataType &d1)

  Scalar multiplication.
- template<class dataType >
  os::indirectMatrix< dataType > **operator**/ (const **os::indirectMatrix**< dataType > &m1, const dataType &d1)

  Scalar division.
- template<class dataType >
  std::ostream & **operator**<< (std::ostream &os, const **os::matrix**< dataType > &dt)

  Prints out a matrix.
- template<class dataType >
  std::ostream & **operator**<< (std::ostream &os, const **os::indirectMatrix**< dataType > &dt)

  Prints out a matrix.

9.9.1 Detailed Description

Matrix templates.

Author

Jonathan Bedard

Date

2/2/2016

Bug No known bugs.

This file contains two template class definitions for matrices. One of these is an "indirect" matrix, meaning that the is an array of pointers, and the other is a direct matrix, meaning the matrix is an array of values.

9.9.2 Function Documentation

template<class dataType > bool operator!= (const **os::matrix**< dataType > & m1, const **os::matrix**< dataType > & m2)

Test for inequality.
Calls '==' and then inverts the result. Depends on the '!=' operator of dataType.

Parameters

in	*m1*	Raw matrix reference
in	*m2*	Raw matrix reference

Returns

False if exactly equivalent

template<class dataType > bool operator!= (const **os::indirectMatrix**< dataType > & m1, const **os::matrix**< dataType > & m2)

Test for inequality.
Calls '==' and then inverts the result. Depends on the '!=' operator of dataType.

Parameters

in	*m1*	Indirect matrix reference
in	*m2*	Raw matrix reference

Returns

False if exactly equivalent

template<class dataType > bool operator!= (const **os::matrix**< dataType > & m1, const **os::indirectMatrix**< dataType > & m2)

Test for inequality.
Calls '==' and then inverts the result. Depends on the '!=' operator of dataType.

Parameters

in	*m1*	Raw matrix reference
in	*m2*	Indirect matrix reference

Returns

False if exactly equivalent

template<class dataType > bool operator!= (const **os::indirectMatrix**< dataType > & m1, const **os::indirectMatrix**< dataType > & m2)

Test for inequality.

Calls '==' and then inverts the result. Depends on the '!=' operator of dataType.

Parameters

in	*m1*	Indirect matrix reference
in	*m2*	Indirect matrix reference

Returns

False if exactly equivalent

template<class dataType > **os::matrix**<dataType> operator∗ (const **os::matrix**< dataType > & m1, const **os::matrix**< dataType > & m2)

Cross-product.

Preforms the cross-product. The cross- product is undefined if the width of m1 does not equal the height of m2. If the cross-product is undefined, a matrix of size (0,0) will be returned. Depends on the '∗' and '+=' operator of the dataType.

Parameters

in	*m1*	Raw matrix reference
in	*m2*	Raw matrix reference

Returns

m1 x m2 (raw matrix)

template<class dataType > **os::matrix**<dataType> operator∗ (const **os::indirectMatrix**< dataType > & m1, const **os::matrix**< dataType > & m2)

Cross-product.

Preforms the cross-product. The cross- product is undefined if the width of m1 does not equal the height of m2. If the cross-product is undefined, a matrix of size (0,0) will be returned. Depends on the '∗' and '+=' operator of the dataType.

Parameters

in	*m1*	Indirect matrix reference
in	*m2*	Raw matrix reference

Returns

m1 x m2 (raw matrix)

template<class dataType > **os::matrix**<dataType> operator∗ (const **os::matrix**< dataType > & m1, const **os::indirectMatrix**< dataType > & m2)

Cross-product.

Preforms the cross-product. The cross- product is undefined if the width of m1 does not equal the height of m2. If the cross-product is undefined, a matrix of size (0,0) will be returned. Depends on the '∗' and '+=' operator of the dataType.

Parameters

in	*m1*	Raw matrix reference
in	*m2*	Indirect matrix reference

Returns

m1 x m2 (raw matrix)

template<class dataType > **os::indirectMatrix**<dataType> operator∗ (const **os::indirectMatrix**< dataType > & m1, const **os::indirectMatrix**< dataType > & m2)

Cross-product.

Preforms the cross-product. The cross- product is undefined if the width of m1 does not equal the height of m2. If the cross-product is undefined, a matrix of size (0,0) will be returned. Depends on the '∗' and '+=' operator of the dataType.

Parameters

in	*m1*	Indirect matrix reference
in	*m2*	Indirect matrix reference

Returns

m1 x m2 (indirect matrix)

template<class dataType > **os::matrix**<dataType> operator∗ (const dataType & d1, const **os::matrix**< dataType > & m1)

Scalar multiplication.

Multiplies a matrix by a constant. This function depends on the '∗' operator of the dataType.

Parameters

in	*d1*	Scalar data type
in	*m1*	Raw matrix reference

Returns

d1 ∗ m1 (raw matrix)

template<class dataType > **os::matrix**<dataType> operator∗ (const **os::matrix**< dataType > & m1, const dataType & d1)

Scalar multiplication.

Multiplies a matrix by a constant. This function depends on the '∗' operator of the dataType.

Parameters

in	*m1*	Raw matrix reference
in	*d1*	Scalar data type

Returns

d1 ∗ m1 (raw matrix)

template<class dataType > **os::indirectMatrix**<dataType> operator∗ (const dataType & d1, const **os::indirectMatrix**< dataType > & m1)

Scalar multiplication.

Multiplies an indirect matrix by a constant. This function depends on the '∗' operator of the data↩ Type.

Parameters

in	*d1*	Scalar data type
in	*m1*	Indirect matrix reference

Returns

d1 ∗ m1 (indirect matrix)

template<class dataType > **os::indirectMatrix**<dataType> operator∗ (const **os::indirectMatrix**< dataType > & m1, const dataType & d1)

Scalar multiplication.

Multiplies an indirect matrix by a constant. This function depends on the '∗' operator of the data↩ Type.

Parameters

in	*m1*	Indirect matrix reference
in	*d1*	Scalar data type

Returns

d1 * m1 (indirect matrix)

template<class dataType > **os::matrix**<dataType> operator+ (const **os::matrix**< dataType > & m1, const **os::matrix**< dataType > & m2)

Addition.

Preforms matrix addition. Matrix addition is undefined if the two matrices are of different size. If the operation is undefined, a matrix of size (0,0) will be returned. Depends on the '+' operator of dataType.

Parameters

in	*m1*	Raw matrix reference
in	*m2*	Raw matrix reference

Returns

m1 + m2 (raw matrix)

template<class dataType > **os::matrix**<dataType> operator+ (const **os::indirectMatrix**< dataType > & m1, const **os::matrix**< dataType > & m2)

Addition.

Preforms matrix addition. Matrix addition is undefined if the two matrices are of different size. If the operation is undefined, a matrix of size (0,0) will be returned. Depends on the '+' operator of dataType.

Parameters

in	*m1*	Indirect matrix reference
in	*m2*	Raw matrix reference

Returns

m1 + m2 (raw matrix)

template<class dataType > **os::matrix**<dataType> operator+ (const **os::matrix**< dataType > & m1, const **os::indirectMatrix**< dataType > & m2)

Addition.

Preforms matrix addition. Matrix addition is undefined if the two matrices are of different size. If the operation is undefined, a matrix of size (0,0) will be returned. Depends on the '+' operator of dataType.

Parameters

in	*m1*	Raw matrix reference
in	*m2*	Indirect matrix reference

Returns

m1 + m2 (raw matrix)

template<class dataType > **os::indirectMatrix**<dataType> operator+ (const **os::indirectMatrix**< dataType > & m1, const **os::indirectMatrix**< dataType > & m2)

Addition.

Preforms matrix addition. Matrix addition is undefined if the two matrices are of different size. If the operation is undefined, a matrix of size (0,0) will be returned. Depends on the '+' operator of dataType.

Parameters

in	*m1*	Indirect matrix reference
in	*m2*	Indirect matrix reference

Returns

m1 + m2 (indirect matrix)

template<class dataType > **os::matrix**<dataType> operator- (const **os::matrix**< dataType > & m1, const **os::matrix**< dataType > & m2)

Subtraction.

Preforms matrix subtraction. Matrix subtraction is undefined if the two matrices are of different size. If the operation is undefined, a matrix of size (0,0) will be returned. Depends on the '-' operator of dataType.

Parameters

in	*m1*	Raw matrix reference
in	*m2*	Raw matrix reference

Returns

m1 - m2 (raw matrix)

template<class dataType > **os::matrix**<dataType> operator- (const **os::indirectMatrix**< dataType > & m1, const **os::matrix**< dataType > & m2)

Subtraction.

Preforms matrix subtraction. Matrix subtraction is undefined if the two matrices are of different size. If the operation is undefined, a matrix of size (0,0) will be returned. Depends on the '-' operator of dataType.

Parameters

in	*m1*	Indirect matrix reference
in	*m2*	Raw matrix reference

Returns

m1 - m2 (raw matrix)

template<class dataType > **os::matrix**<dataType> operator- (const **os::matrix**< dataType > & m1, const **os::indirectMatrix**< dataType > & m2)

Subtraction.

Preforms matrix subtraction. Matrix subtraction is undefined if the two matrices are of different size. If the operation is undefined, a matrix of size (0,0) will be returned. Depends on the '-' operator of dataType.

Parameters

in	*m1*	Raw matrix reference
in	*m2*	Indirect matrix reference

Returns

m1 - m2 (raw matrix)

template<class dataType > **os::indirectMatrix**<dataType> operator- (const **os::indirectMatrix**< dataType > & m1, const **os::indirectMatrix**< dataType > & m2)

Subtraction.

Preforms matrix subtraction. Matrix subtraction is undefined if the two matrices are of different size. If the operation is undefined, a matrix of size (0,0) will be returned. Depends on the '-' operator of dataType.

Parameters

in	*m1*	Indirect matrix reference
in	*m2*	Indirect matrix reference

Returns

m1 - m2 (indirect matrix)

template<class dataType > **os::matrix**<dataType> operator/ (const **os::matrix**< dataType > & m1, const dataType & d1)

Scalar division.

Divides a matrix by a constant. This function depends on the '/' operator of the dataType. No zero check, as the dataType is not defined.

Parameters

in	*m1*	Raw matrix reference
in	*d1*	Scalar data type

Returns

m1/d (raw matrix)

template<class dataType > **os::indirectMatrix**<dataType> operator/ (const **os::indirectMatrix**< dataType > & m1, const dataType & d1)

Scalar division.

Divides an indirect matrix by a constant. This function depends on the '/' operator of the dataType. No zero check, as the dataType is not defined.

Parameters

in	*m1*	Raw matrix reference
in	*d1*	Scalar data type

Returns

m1/d (raw matrix)

template<class dataType > std::ostream& operator<< (std::ostream & os, const **os::matrix**< dataType > & dt)

Prints out a matrix.

Prints out the entire matrix in the provided output stream. This matrix will be printed out in text form and requires the dataType of the matrix to define an ostream operator.

Parameters

	[in/out]	os std::ostream reference
in	*dt*	Raw matrix reference

Returns

std::ostream os

template<class dataType > std::ostream& operator<< (std::ostream & os, const **os::indirectMatrix**< dataType > & dt)

Prints out a matrix.

Prints out the entire matrix in the provided output stream. This matrix will be printed out in text form and requires the dataType of the matrix to define an ostream operator.

Parameters

	[in/out]	os std::ostream reference
in	*dt*	Indirect matrix reference

Returns

std::ostream os

template<class dataType > bool operator== (const **os::matrix**< dataType > & m1, const **os::matrix**< dataType > & m2)

Test for equality.

Tests the two matrices for equal size and then tests each matrix element for equality as well. This function is dependent on the '!=' definition of the dataType.

Parameters

in	*m1*	Raw matrix reference
in	*m2*	Raw matrix reference

Returns

True if exactly equivalent

template<class dataType > bool operator== (const **os::indirectMatrix**< dataType > & m1, const **os::matrix**< dataType > & m2)

Test for equality.

Tests the two matrices for equal size and then tests each matrix element for equality as well. This function is dependent on the '!=' definition of the dataType.

Parameters

in	*m1*	Indirect matrix reference
in	*m2*	Raw matrix reference

Returns

True if exactly equivalent

template<class dataType > bool operator== (const **os::matrix**< dataType > & m1, const **os::indirectMatrix**< dataType > & m2)

Test for equality.

Tests the two matrices for equal size and then tests each matrix element for equality as well. This function is dependent on the '!=' definition of the dataType.

Parameters

in	*m1*	Raw matrix reference
in	*m2*	Indirect matrix reference

Returns

True if exactly equivalent

template<class dataType > bool operator== (const **os::indirectMatrix**< dataType > & m1, const **os::indirectMatrix**< dataType > & m2)

Test for equality.

Tests the two matrices for equal size and then tests each matrix element for equality as well. This function is dependent on the '!=' definition of the dataType.

Parameters

in	*m1*	Indirect matrix reference
in	*m2*	Indirect matrix reference

Returns

True if exactly equivalent

9.10 osLogger.h File Reference

Logging for os namespace.

Namespaces

- **os**

Functions

- std::ostream & **os::osout_func** ()

  Standard out object for os namespace.

- std::ostream & **os::oserr_func** ()

  Standard error object for os namespace.

Variables

- smart_ptr< std::ostream > **os::osout_ptr**

  Standard out pointer for os namespace.
- smart_ptr< std::ostream > **os::oserr_ptr**

  Standard error pointer for os namespace.

9.10.1 Detailed Description

Logging for os namespace.
Jonathan Bedard

Date

1/30/2016

Bug No known bugs.

This file contains declarations which are used for logging within the os namespace.

9.11 osLogger.cpp File Reference

Logging for os namespace, implementation.

9.11.1 Detailed Description

Logging for os namespace, implementation.
Jonathan Bedard

Date

2/15/2016

Bug No known bugs.

This file contains global functions and variables used for logging in the os namespace.

9.12 osVectors.h File Reference

Vector templates.

Classes

- class **os::vector2d**< **dataType** >

  2-dimensional vector
- class **os::vector3d**< **dataType** >

  3-dimensional vector

Namespaces

- **os**

Typedefs

- typedef vector2d< int8_t > **os::vector2d_8**
  8 bit 2-d vector
- typedef vector2d< uint8_t > **os::vector2d_u8**
  unsigned 8 bit 2-d vector
- typedef vector2d< int16_t > **os::vector2d_16**
  16 bit 2-d vector
- typedef vector2d< uint16_t > **os::vector2d_u16**
  unsigned 16 bit 2-d vector
- typedef vector2d< int32_t > **os::vector2d_32**
  32 bit 2-d vector
- typedef vector2d< uint32_t > **os::vector2d_u32**
  unsigned 32 bit 2-d vector
- typedef vector2d< int64_t > **os::vector2d_64**
  64 bit 2-d vector
- typedef vector2d< uint64_t > **os::vector2d_u64**
  unsigned 64 bit 2-d vector
- typedef vector2d< float > **os::vector2d_f**
  float 2-d vector
- typedef vector2d< double > **os::vector2d_d**
  double 2-d vector
- typedef vector3d< int8_t > **os::vector3d_8**
  8 bit 3-d vector
- typedef vector3d< uint8_t > **os::vector3d_u8**
  unsigned 8 bit 3-d vector
- typedef vector3d< int16_t > **os::vector3d_16**
  16 bit 3-d vector
- typedef vector3d< uint16_t > **os::vector3d_u16**
  unsigned 16 bit 3-d vector
- typedef vector3d< int32_t > **os::vector3d_32**
  32 bit 3-d vector
- typedef vector3d< uint32_t > **os::vector3d_u32**
  unsigned 32 bit 3-d vector
- typedef vector3d< int64_t > **os::vector3d_64**
  64 bit 3-d vector
- typedef vector3d< uint64_t > **os::vector3d_u64**
  unsigned 64 bit 3-d vector
- typedef vector3d< float > **os::vector3d_f**
  float 3-d vector
- typedef vector3d< double > **os::vector3d_d**
  double 3-d vector

9.12.1 Detailed Description

Vector templates.

Author

Jonathan Bedard

Date

3/12/2016

Bug No known bugs.

This file contains two template classes defining vector objects. Vectors can, in a broad sense, be used for any class which defines general mathematical operations. This particular file offers vector type definitions for all of the basic integer and floating point types.

9.13 set.h File Reference

Smart Set.

Classes

- class **os::smartSet**< **dataType** >
  Smart set abstract data-structures.

Namespaces

- **os**

Enumerations

- enum **os::setTypes** { **os::def_set** =0, **os::small_set**, **os::sorted_set** }
  Index of abstract data-structures.

9.13.1 Detailed Description

Smart Set.

Author

Jonathan Bedard

Date

2/12/2016

Bug No known bugs.

This file contains a template class defining a "smart set." A smart set wraps other forms of abstract data structures, allowing applications to define abstract data-structures by numbered indexes.

9.14 smartPointer.h File Reference

Template declaration of **os::smart_ptr** (p. 146).

Classes

- class **os::smart_ptr**< **dataType** >
  Reference counted pointer.

Namespaces

- **os**

Typedefs

- typedef void(∗ **os::void_rec**) (void ∗)
  Deletion function typedef.

Enumerations

- enum **os::smart_pointer_type** {
  os::null_type =0, **os::raw_type**, **os::shared_type**, **os::shared_type_array**,
  os::shared_type_dynamic_delete }
  *Enumeration for types of **os::smart_ptr** (p. 146).*

Functions

- template<class targ , class src >
  smart_ptr< targ > **os::cast** (const **os::smart_ptr**< src > &conv)
  ***os::smart_ptr** (p. 146) cast function*
- template<class dataType >
  bool **operator==** (const **os::smart_ptr**< dataType > &c1, const **os::smart_ptr**< dataType > &c2)
- template<class dataType >
  bool **operator==** (const **os::smart_ptr**< dataType > &c1, const dataType ∗c2)
- template<class dataType >
  bool **operator==** (const dataType ∗c1, const **os::smart_ptr**< dataType > &c2)
- template<class dataType >
  bool **operator==** (const **os::smart_ptr**< dataType > &c1, const void ∗c2)
- template<class dataType >
  bool **operator==** (const void ∗c1, const **os::smart_ptr**< dataType > &c2)
- template<class dataType >
  bool **operator==** (const **os::smart_ptr**< dataType > &c1, const int c2)
- template<class dataType >
  bool **operator==** (const int c1, const **os::smart_ptr**< dataType > &c2)
- template<class dataType >
  bool **operator==** (const **os::smart_ptr**< dataType > &c1, const long c2)

- template<class dataType >
  bool **operator==** (const long c1, const **os::smart_ptr**< dataType > &c2)
- template<class dataType >
  bool **operator==** (const **os::smart_ptr**< dataType > &c1, const unsigned long c2)
- template<class dataType >
  bool **operator==** (const unsigned long c1, const **os::smart_ptr**< dataType > &c2)
- template<class dataType >
  bool **operator!=** (const **os::smart_ptr**< dataType > &c1, const **os::smart_ptr**< dataType > &c2)
- template<class dataType >
  bool **operator!=** (const **os::smart_ptr**< dataType > &c1, const dataType *c2)
- template<class dataType >
  bool **operator!=** (const dataType *c1, const **os::smart_ptr**< dataType > &c2)
- template<class dataType >
  bool **operator!=** (const **os::smart_ptr**< dataType > &c1, const void *c2)
- template<class dataType >
  bool **operator!=** (const void *c1, const **os::smart_ptr**< dataType > &c2)
- template<class dataType >
  bool **operator!=** (const **os::smart_ptr**< dataType > &c1, const int c2)
- template<class dataType >
  bool **operator!=** (const int c1, const **os::smart_ptr**< dataType > &c2)
- template<class dataType >
  bool **operator!=** (const **os::smart_ptr**< dataType > &c1, const long c2)
- template<class dataType >
  bool **operator!=** (const long c1, const **os::smart_ptr**< dataType > &c2)
- template<class dataType >
  bool **operator!=** (const **os::smart_ptr**< dataType > &c1, const unsigned long c2)
- template<class dataType >
  bool **operator!=** (const unsigned long c1, const **os::smart_ptr**< dataType > &c2)
- template<class dataType >
  bool **operator**< (const **os::smart_ptr**< dataType > &c1, const **os::smart_ptr**< dataType > &c2)
- template<class dataType >
  bool **operator**< (const **os::smart_ptr**< dataType > &c1, const dataType *c2)
- template<class dataType >
  bool **operator**< (const dataType *c1, const **os::smart_ptr**< dataType > &c2)
- template<class dataType >
  bool **operator**< (const **os::smart_ptr**< dataType > &c1, const void *c2)
- template<class dataType >
  bool **operator**< (const void *c1, const **os::smart_ptr**< dataType > &c2)
- template<class dataType >
  bool **operator**< (const **os::smart_ptr**< dataType > &c1, const int c2)
- template<class dataType >
  bool **operator**< (const int c1, const **os::smart_ptr**< dataType > &c2)
- template<class dataType >
  bool **operator**< (const **os::smart_ptr**< dataType > &c1, const long c2)
- template<class dataType >
  bool **operator**< (const long c1, const **os::smart_ptr**< dataType > &c2)

- template<class dataType >
  bool **operator**< (const **os::smart_ptr**< dataType > &c1, const unsigned long c2)
- template<class dataType >
  bool **operator**< (const unsigned long c1, const **os::smart_ptr**< dataType > &c2)
- template<class dataType >
  bool **operator**<**=** (const **os::smart_ptr**< dataType > &c1, const **os::smart_ptr**< dataType > &c2)
- template<class dataType >
  bool **operator**<**=** (const **os::smart_ptr**< dataType > &c1, const dataType ∗c2)
- template<class dataType >
  bool **operator**<**=** (const dataType ∗c1, const **os::smart_ptr**< dataType > &c2)
- template<class dataType >
  bool **operator**<**=** (const **os::smart_ptr**< dataType > &c1, const void ∗c2)
- template<class dataType >
  bool **operator**<**=** (const void ∗c1, const **os::smart_ptr**< dataType > &c2)
- template<class dataType >
  bool **operator**<**=** (const **os::smart_ptr**< dataType > &c1, const int c2)
- template<class dataType >
  bool **operator**<**=** (const int c1, const **os::smart_ptr**< dataType > &c2)
- template<class dataType >
  bool **operator**<**=** (const **os::smart_ptr**< dataType > &c1, const long c2)
- template<class dataType >
  bool **operator**<**=** (const long c1, const **os::smart_ptr**< dataType > &c2)
- template<class dataType >
  bool **operator**<**=** (const **os::smart_ptr**< dataType > &c1, const unsigned long c2)
- template<class dataType >
  bool **operator**<**=** (const unsigned long c1, const **os::smart_ptr**< dataType > &c2)
- template<class dataType >
  bool **operator**> (const **os::smart_ptr**< dataType > &c1, const **os::smart_ptr**< dataType > &c2)
- template<class dataType >
  bool **operator**> (const **os::smart_ptr**< dataType > &c1, const dataType ∗&c2)
- template<class dataType >
  bool **operator**> (const dataType ∗&c1, const **os::smart_ptr**< dataType > &c2)
- template<class dataType >
  bool **operator**> (const **os::smart_ptr**< dataType > &c1, const void ∗c2)
- template<class dataType >
  bool **operator**> (const void ∗c1, const **os::smart_ptr**< dataType > &c2)
- template<class dataType >
  bool **operator**> (const **os::smart_ptr**< dataType > &c1, const int c2)
- template<class dataType >
  bool **operator**> (const int c1, const **os::smart_ptr**< dataType > &c2)
- template<class dataType >
  bool **operator**> (const **os::smart_ptr**< dataType > &c1, const long c2)
- template<class dataType >
  bool **operator**> (const long c1, const **os::smart_ptr**< dataType > &c2)
- template<class dataType >
  bool **operator**> (const **os::smart_ptr**< dataType > &c1, const unsigned long c2)

- template<class dataType >
  bool **operator**> (const unsigned long c1, const **os::smart_ptr**< dataType > &c2)
- template<class dataType >
  bool **operator**>**=** (const **os::smart_ptr**< dataType > &c1, const **os::smart_ptr**< dataType > &c2)
- template<class dataType >
  bool **operator**>**=** (const **os::smart_ptr**< dataType > &c1, const dataType *&c2)
- template<class dataType >
  bool **operator**>**=** (const dataType *&c1, const **os::smart_ptr**< dataType > &c2)
- template<class dataType >
  bool **operator**>**=** (const **os::smart_ptr**< dataType > &c1, const void *c2)
- template<class dataType >
  bool **operator**>**=** (const void *c1, const **os::smart_ptr**< dataType > &c2)
- template<class dataType >
  bool **operator**>**=** (const **os::smart_ptr**< dataType > &c1, const int c2)
- template<class dataType >
  bool **operator**>**=** (const int c1, const **os::smart_ptr**< dataType > &c2)
- template<class dataType >
  bool **operator**>**=** (const **os::smart_ptr**< dataType > &c1, const long c2)
- template<class dataType >
  bool **operator**>**=** (const long c1, const **os::smart_ptr**< dataType > &c2)
- template<class dataType >
  bool **operator**>**=** (const **os::smart_ptr**< dataType > &c1, const unsigned long c2)
- template<class dataType >
  bool **operator**>**=** (const unsigned long c1, const **os::smart_ptr**< dataType > &c2)

9.14.1 Detailed Description

Template declaration of **os::smart_ptr** (p. 146).

Author

Jonathan Bedard

Date

4/18/2016

Bug No known bugs.

This file contains a template declaration of **os::smart_ptr** (p. 146) and supporting constants and functions. Note that because **os::smart_ptr** (p. 146) is a template class, the implimentation of **os::smart_ptr** (p. 146) occurs here as well.

9.14.2 Function Documentation

template<class dataType > bool operator!= (const **os::smart_ptr**< dataType > & c1, const **os::smart_ptr**< dataType > & c2) `[inline]`

template<class dataType > bool operator!= (const **os::smart_ptr**< dataType > & c1, const dataType * c2) [inline]

template<class dataType > bool operator!= (const dataType * c1, const **os::smart_ptr**< dataType > & c2) [inline]

template<class dataType > bool operator!= (const **os::smart_ptr**< dataType > & c1, const void * c2) [inline]

template<class dataType > bool operator!= (const void * c1, const **os::smart_ptr**< dataType > & c2) [inline]

template<class dataType > bool operator!= (const **os::smart_ptr**< dataType > & c1, const int c2) [inline]

template<class dataType > bool operator!= (const int c1, const **os::smart_ptr**< dataType > & c2) [inline]

template<class dataType > bool operator!= (const **os::smart_ptr**< dataType > & c1, const long c2) [inline]

template<class dataType > bool operator!= (const long c1, const **os::smart_ptr**< dataType > & c2) [inline]

template<class dataType > bool operator!= (const **os::smart_ptr**< dataType > & c1, const unsigned long c2) [inline]

template<class dataType > bool operator!= (const unsigned long c1, const **os::smart_ptr**< dataType > & c2) [inline]

template<class dataType > bool operator< (const **os::smart_ptr**< dataType > & c1, const **os::smart_ptr**< dataType > & c2) [inline]

template<class dataType > bool operator< (const **os::smart_ptr**< dataType > & c1, const dataType * c2) [inline]

template<class dataType > bool operator< (const dataType * c1, const **os::smart_ptr**< dataType > & c2) [inline]

template<class dataType > bool operator< (const **os::smart_ptr**< dataType > & c1, const void * c2) [inline]

template<class dataType > bool operator< (const void * c1, const **os::smart_ptr**< dataType > & c2) [inline]

template<class dataType > bool operator< (const **os::smart_ptr**< dataType > & c1, const int c2) [inline]

template<class dataType > bool operator< (const int c1, const **os::smart_ptr**< dataType > & c2) [inline]

template<class dataType > bool operator< (const **os::smart_ptr**< dataType > & c1, const long c2) [inline]

template<class dataType > bool operator< (const long c1, const **os::smart_ptr**< dataType > & c2) [inline]

template<class dataType > bool operator< (const **os::smart_ptr**< dataType > & c1, const unsigned long c2) [inline]

template<class dataType > bool operator< (const unsigned long c1, const **os::smart_ptr**< dataType > & c2) [inline]

template<class dataType > bool operator<= (const **os::smart_ptr**< dataType > & c1, const **os::smart_ptr**< dataType > & c2) [inline]

template<class dataType > bool operator<= (const **os::smart_ptr**< dataType > & c1, const dataType * c2) [inline]

template<class dataType > bool operator<= (const dataType * c1, const **os::smart_ptr**< dataType > & c2) [inline]

template<class dataType > bool operator<= (const **os::smart_ptr**< dataType > & c1, const void * c2) [inline]

template<class dataType > bool operator<= (const void * c1, const **os::smart_ptr**< dataType > & c2) [inline]

template<class dataType > bool operator<= (const **os::smart_ptr**< dataType > & c1, const int c2) [inline]

template<class dataType > bool operator<= (const int c1, const **os::smart_ptr**< dataType > & c2) [inline]

template<class dataType > bool operator<= (const **os::smart_ptr**< dataType > & c1, const long c2) [inline]

template<class dataType > bool operator<= (const long c1, const **os::smart_ptr**< dataType > & c2) [inline]

template<class dataType > bool operator<= (const **os::smart_ptr**< dataType > & c1, const unsigned long c2) [inline]

template<class dataType > bool operator<= (const unsigned long c1, const **os::smart_ptr**< dataType > & c2) [inline]

template<class dataType > bool operator== (const **os::smart_ptr**< dataType > & c1, const **os::smart_ptr**< dataType > & c2) [inline]

template<class dataType > bool operator== (const **os::smart_ptr**< dataType > & c1, const dataType * c2) [inline]

template<class dataType > bool operator== (const dataType * c1, const **os::smart_ptr**< dataType > & c2) [inline]

template<class dataType > bool operator== (const **os::smart_ptr**< dataType > & c1, const void * c2) [inline]

template<class dataType > bool operator== (const void * c1, const **os::smart_ptr**< dataType > & c2) [inline]

template<class dataType > bool operator== (const **os::smart_ptr**< dataType > & c1, const int c2) [inline]

template<class dataType > bool operator== (const int c1, const **os::smart_ptr**< dataType > & c2) [inline]

template<class dataType > bool operator== (const **os::smart_ptr**< dataType > & c1, const long c2) [inline]

template<class dataType > bool operator== (const long c1, const **os::smart_ptr**< dataType > & c2) [inline]

template<class dataType > bool operator== (const **os::smart_ptr**< dataType > & c1, const unsigned long c2) [inline]

template<class dataType > bool operator== (const unsigned long c1, const **os::smart_ptr**< dataType > & c2) [inline]

template<class dataType > bool operator> (const **os::smart_ptr**< dataType > & c1, const **os::smart_ptr**< dataType > & c2) [inline]

template<class dataType > bool operator> (const **os::smart_ptr**< dataType > & c1, const dataType *& c2) [inline]

template<class dataType > bool operator> (const dataType *& c1, const **os::smart_ptr**< dataType > & c2) [inline]

template<class dataType > bool operator> (const **os::smart_ptr**< dataType > & c1, const void * c2) [inline]

template<class dataType > bool operator> (const void * c1, const **os::smart_ptr**< dataType > & c2) [inline]

template<class dataType > bool operator> (const **os::smart_ptr**< dataType > & c1, const int c2) [inline]

template<class dataType > bool operator> (const int c1, const **os::smart_ptr**< dataType > & c2) [inline]

template<class dataType > bool operator> (const **os::smart_ptr**< dataType > & c1, const long c2) [inline]

template<class dataType > bool operator> (const long c1, const **os::smart_ptr**< dataType > & c2) [inline]

template<class dataType > bool operator> (const **os::smart_ptr**< dataType > & c1, const unsigned long c2) [inline]

template<class dataType > bool operator> (const unsigned long c1, const **os::smart_ptr**< dataType > & c2) [inline]

template<class dataType > bool operator>= (const **os::smart_ptr**< dataType > & c1, const **os::smart_ptr**< dataType > & c2) [inline]

template<class dataType > bool operator>= (const **os::smart_ptr**< dataType > & c1, const dataType *& c2) [inline]

template<class dataType > bool operator>= (const dataType *& c1, const **os::smart_ptr**< dataType > & c2) [inline]

template<class dataType > bool operator>= (const **os::smart_ptr**< dataType > & c1, const void * c2) [inline]

template<class dataType > bool operator>= (const void * c1, const **os::smart_ptr**< dataType > & c2) [inline]

template<class dataType > bool operator>= (const **os::smart_ptr**< dataType > & c1, const int c2) [inline]

template<class dataType > bool operator>= (const int c1, const **os::smart_ptr**< dataType > & c2) [inline]

template<class dataType > bool operator>= (const **os::smart_ptr**< dataType > & c1, const long c2) [inline]

template<class dataType > bool operator>= (const long c1, const **os::smart_ptr**< dataType > & c2) [inline]

template<class dataType > bool operator>= (const **os::smart_ptr**< dataType > & c1, const unsigned long c2) [inline]

template<class dataType > bool operator>= (const unsigned long c1, const **os::smart_ptr**< dataType > & c2) [inline]

9.15 staticConstantPrinter.h File Reference

Constant printing support.

Classes

- class **os::constantPrinter**

  Prints constant arrays to files.

Namespaces

- **os**

9.15.1 Detailed Description

Constant printing support.

Author

Jonathan Bedard

Date

1/31/2016

Bug No known bugs.

This file contains a class which helps facilitate printing massive tables of constants. It outputs .h and .cpp files with configured arrays of constants.

9.16 staticConstantPrinter.cpp File Reference

Constant printing support, implementation.

9.16.1 Detailed Description

Constant printing support, implementation.

Author

Jonathan Bedard

Date

4/618/2016

Bug No known bugs.

This file implements **os::constantPrinter** (p. 124). Consult **staticConstantPrinter.h** (p. 74) for detailed documentation.

Chapter 10

Class Index

10.1 Class List

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

Chapter 11

Namespace Documentation

11.1 os Namespace Reference

Classes

- class **adnode**

  Abstract data-node.
- class **ads**

  Abstract datastructure.
- class **asyncAVLNode**

  Node for usage in an asynchronous AVL tree.
- class **asyncAVLTree**

  Asynchronous balanced binary search tree.
- class **AVLNode**

  Node for usage in an AVL tree.
- class **AVLTree**

  Balanced binary search tree.
- class **constantPrinter**

  Prints constant arrays to files.
- class **eventReceiver**

  Class which enables event receiving.
- class **eventSender**

  Class which enables event sending.
- class **indirectMatrix**

  Indirect matrix.
- class **matrix**

  Raw matrix.
- class **ptrComp**

  Pointer compare interface.
- class **smart_ptr**

  Reference counted pointer.

- class **smartSet**

  Smart set abstract data-structures.
- class **unsortedList**

  Unsorted linked list.
- class **unsortedListNode**

  Node for usage in a linked list.
- class **vector2d**

  2-dimensional vector
- class **vector3d**

  3-dimensional vector

Typedefs

- typedef **vector2d**< int8_t > **vector2d_8**

  8 bit 2-d vector
- typedef **vector2d**< uint8_t > **vector2d_u8**

  unsigned 8 bit 2-d vector
- typedef **vector2d**< int16_t > **vector2d_16**

  16 bit 2-d vector
- typedef **vector2d**< uint16_t > **vector2d_u16**

  unsigned 16 bit 2-d vector
- typedef **vector2d**< int32_t > **vector2d_32**

  32 bit 2-d vector
- typedef **vector2d**< uint32_t > **vector2d_u32**

  unsigned 32 bit 2-d vector
- typedef **vector2d**< int64_t > **vector2d_64**

  64 bit 2-d vector
- typedef **vector2d**< uint64_t > **vector2d_u64**

  unsigned 64 bit 2-d vector
- typedef **vector2d**< float > **vector2d_f**

  float 2-d vector
- typedef **vector2d**< double > **vector2d_d**

  double 2-d vector
- typedef **vector3d**< int8_t > **vector3d_8**

  8 bit 3-d vector
- typedef **vector3d**< uint8_t > **vector3d_u8**

  unsigned 8 bit 3-d vector
- typedef **vector3d**< int16_t > **vector3d_16**

  16 bit 3-d vector
- typedef **vector3d**< uint16_t > **vector3d_u16**

  unsigned 16 bit 3-d vector
- typedef **vector3d**< int32_t > **vector3d_32**

  32 bit 3-d vector

- typedef **vector3d**< uint32_t > **vector3d_u32**

  unsigned 32 bit 3-d vector
- typedef **vector3d**< int64_t > **vector3d_64**

  64 bit 3-d vector
- typedef **vector3d**< uint64_t > **vector3d_u64**

  unsigned 64 bit 3-d vector
- typedef **vector3d**< float > **vector3d_f**

  float 3-d vector
- typedef **vector3d**< double > **vector3d_d**

  double 3-d vector
- typedef void(∗ **void_rec**) (void ∗)

  Deletion function typedef.

Enumerations

- enum **setTypes** { **def_set** =0, **small_set**, **sorted_set** }

  Index of abstract data-structures.
- enum **smart_pointer_type** {
  null_type =0, **raw_type**, **shared_type**, **shared_type_array**,
  shared_type_dynamic_delete }

  *Enumeration for types of **os::smart_ptr** (p. 146).*

Functions

- template<class dataType >
  int **defaultCompareSort** (const dataType &v1, const dataType &v2)

  Basic compare.
- template<class dataType >
  int **pointerCompareSort** (**smart_ptr**< dataType > ptr1, **smart_ptr**< dataType > ptr2)

  Raw pointer compare.
- template<class dataType >
  void **quicksort** (dataType ∗arr, unsigned int length, int(∗sort_comparison)(const dataType &, const dataType &)=&**defaultCompareSort**)

  Template quick-sort.
- template<class dataType >
  void **pointerQuicksort** (**smart_ptr**< **smart_ptr**< dataType > > arr, unsigned int length, int(∗sort↩
  _comparison)(**smart_ptr**< dataType >, **smart_ptr**< dataType >)=&**pointerCompareSort**)

  Template for quick-sort, pointer version.
- template<class dataType >
  bool **compareSize** (const **matrix**< dataType > &m1, const **matrix**< dataType > &m2)

  Compares the size of two matrices.
- template<class dataType >
  bool **compareSize** (const **indirectMatrix**< dataType > &m1, const **matrix**< dataType > &m2)

  Compares the size of two matrices.

- template<class dataType >
  bool **compareSize** (const **matrix**< dataType > &m1, const **indirectMatrix**< dataType > &m2)

  Compares the size of two matrices.
- template<class dataType >
  bool **compareSize** (const **indirectMatrix**< dataType > &m1, const **indirectMatrix**< dataType > &m2)

  Compares the size of two matrices.
- template<class dataType >
  bool **testCross** (const **matrix**< dataType > &m1, const **matrix**< dataType > &m2)

  Tests if the cross-product is a legal operation.
- template<class dataType >
  bool **testCross** (const **indirectMatrix**< dataType > &m1, const **matrix**< dataType > &m2)

  Tests if the cross-product is a legal operation.
- template<class dataType >
  bool **testCross** (const **matrix**< dataType > &m1, const **indirectMatrix**< dataType > &m2)

  Tests if the cross-product is a legal operation.
- template<class dataType >
  bool **testCross** (const **indirectMatrix**< dataType > &m1, const **indirectMatrix**< dataType > &m2)

  Tests if the cross-product is a legal operation.
- std::ostream & **osout_func** ()

  Standard out object for os namespace.
- std::ostream & **oserr_func** ()

  Standard error object for os namespace.
- template<class targ , class src >
  smart_ptr< targ > **cast** (const **os::smart_ptr**< src > &conv)

  os::smart_ptr *(*p. *146) cast function*

Variables

- std::recursive_mutex * **eventLock**

  Event processing mutex.
- **smart_ptr**< std::ostream > **osout_ptr**

  Standard out pointer for os namespace.
- **smart_ptr**< std::ostream > **oserr_ptr**

  Standard error pointer for os namespace.

11.1.1 Typedef Documentation

typedef **vector2d**<int16_t> **os::vector2d_16**

16 bit 2-d vector

typedef **vector2d**<int32_t> **os::vector2d_32**

32 bit 2-d vector

typedef **vector2d**<int64_t> **os::vector2d_64**

64 bit 2-d vector

typedef **vector2d**<int8_t> **os::vector2d_8**

8 bit 2-d vector

typedef **vector2d**<double> **os::vector2d_d**

double 2-d vector

typedef **vector2d**<float> **os::vector2d_f**

float 2-d vector

typedef **vector2d**<uint16_t> **os::vector2d_u16**

unsigned 16 bit 2-d vector

typedef **vector2d**<uint32_t> **os::vector2d_u32**

unsigned 32 bit 2-d vector

typedef **vector2d**<uint64_t> **os::vector2d_u64**

unsigned 64 bit 2-d vector

typedef **vector2d**<uint8_t> **os::vector2d_u8**

unsigned 8 bit 2-d vector

typedef **vector3d**<int16_t> **os::vector3d_16**

16 bit 3-d vector

typedef **vector3d**<int32_t> **os::vector3d_32**

32 bit 3-d vector

typedef **vector3d**<int64_t> **os::vector3d_64**

64 bit 3-d vector

typedef **vector3d**<int8_t> **os::vector3d_8**

8 bit 3-d vector

typedef **vector3d**<double> **os::vector3d_d**

double 3-d vector

typedef **vector3d**<float> **os::vector3d_f**

float 3-d vector

typedef **vector3d**<uint16_t> **os::vector3d_u16**

unsigned 16 bit 3-d vector

typedef **vector3d**<uint32_t> **os::vector3d_u32**

unsigned 32 bit 3-d vector

typedef **vector3d**<uint64_t> **os::vector3d_u64**

unsigned 64 bit 3-d vector

typedef **vector3d**<uint8_t> **os::vector3d_u8**

unsigned 8 bit 3-d vector

typedef void(∗ os::void_rec) (void ∗)

Deletion function typedef.

The **os::void_rec** (p. 83) function pointer typedef is used by **os::smart_ptr** (p. 146) when it is of type **os::shared_type_dynamic_delete** (p. 84) to destroy non-standard pointers, usually when interfacing with C code.

Parameters

`in,out`	*void∗*	designed for non-standard deletion.

Returns

void

11.1.2 Enumeration Type Documentation

enum **os::setTypes**

Index of abstract data-structures.

This enumeration contains a numbered reference to all of the available abstract data-structures.

Enumerator

def_set Default set enumeration. Currently defaults to a small set.

small_set Small memory burden set. The small set uses an unsorted linked list to store data.

sorted_set Sorted set. The sorted set uses an AVL tree to store data.

enum **os::smart_pointer_type**

Enumeration for types of **os::smart_ptr** (p. 146).

Defines types of **os::smart_ptr** (p. 146). These types are used to define the deletion behaviour of the pointer.

Enumerator

null_type No type. **os::null_type** (p. 84) pointers are the default type of **os::smart_ptr** (p. 146). Any **os::smart_ptr** (p. 146) of type **os::null_type** (p. 84) can be guaranteed to hold a NULL pointer.

raw_type Raw pointer. **os::raw_type** (p. 84) pointers are the default type of **os::smart_ptr** (p. 146) when instantiated with a standard pointer. Any **os::smart_ptr** (p. 146) of type **os::raw_type** (p. 84) is not responsible for the deletion of it's pointer and makes no guarantees as to the availability of it's pointer.

shared_type Reference counted pointer. **os::shared_type** (p. 84) pointers must be instantiated from an **os::smart_ptr** (p. 146) of this type or explicitly through **os::smart_ptr** (p. 146) constructor arguments. **os::shared_type** (p. 84) pointers will automatically delete the pointer contained within the object when the reference count of the **os::smart_ptr** (p. 146) reaches 0.

shared_type_array Reference counted array. Similar in usage and instantiation to **os::raw_type** (p. 84). **os::smart_ptr** (p. 146) of type **os::shared_type_array** (p. 84) are designed to be used with array and will run delete [] when the reference count reaches 0 instead of delete.

shared_type_dynamic_delete Reference pointer with non-standard deletion. Similar in usage and instantiation to **os::raw_type** (p. 84). **os::smart_ptr** (p. 146) of type **os::shared_type_dynamic_delete** (p. 84) are used when the deletion of a pointer is not contained within the object destructor. This is specifically designed for interface with C code not using "new" and "delete."

11.1.3 Function Documentation

template<class targ , class src > **smart_ptr**<targ> os::cast (const **os::smart_ptr**< src > & conv) `[inline]`

os::smart_ptr (p. 146) cast function

Casts an os::smart_ptr<src> to and os::smart_ptr<targ>. This function is a template function, targ and src are the templates respectively. Note that the is an explicit cast and is not guranteed to be safe.

Parameters

`in`	*conv*	Reference to os::smart_ptr<src> to be converted

Returns

New os::smart_ptr<targ> constructed from the received **os::smart_ptr** (p. 146)

template<class dataType > bool os::compareSize (const **matrix**< dataType > & m1, const **matrix**< dataType > & m2)

Compares the size of two matrices.

Compares the size of two raw matrices. If both have the same width and the same height, they are considered to be the same size.

Parameters

in	*m1*	Raw matrix reference
in	*m2*	Raw matrix reference

Returns

True if the matrices are the same size

template<class dataType > bool os::compareSize (const **indirectMatrix**< dataType > & m1, const **matrix**< dataType > & m2)

Compares the size of two matrices.

Compares the size of an indirect matrix and a raw matrix in that order. If both have the same width and the same height, they are considered to be the same size.

Parameters

in	*m1*	Indirect matrix reference
in	*m2*	Raw matrix reference

Returns

True if the matrices are the same size

template<class dataType > bool os::compareSize (const **matrix**< dataType > & m1, const **indirectMatrix**< dataType > & m2)

Compares the size of two matrices.

Compares the size of a raw matrix and an indirect matrix in that order. If both have the same width and the same height, they are considered to be the same size.

Parameters

in	*m1*	Raw matrix reference
in	*m2*	Indirect matrix reference

Returns

True if the matrices are the same size

template<class dataType > bool os::compareSize (const **indirectMatrix**< dataType > & m1, const **indirectMatrix**< dataType > & m2)

Compares the size of two matrices.

Compares the size of two indirect matrices. If both have the same width and the same height, they are considered to be the same size.

Parameters

in	*m1*	Indirect matrix reference
in	*m2*	Indirect matrix reference

Returns

True if the matrices are the same size

template<class dataType > int os::defaultCompareSort (const dataType & v1, const dataType & v2)

Basic compare.

Acts as a default comparison function for sorting. This function compares the data as if it is in integer form.

Parameters

in	*v1*	Reference 1 to compare
in	*v2*	Reference 2 to compare

Returns

1 if greater than, -1 if less than, 0 if equal to

std::ostream& os::oserr_func ( )

Standard error object for os namespace.

#define statements allow the user to call this function with "os::oserr." Logging is achieved by using "os::oserr" as one would use "std::cerr."

std::ostream& os::osout_func ( )

Standard out object for os namespace.

#define statements allow the user to call this function with "os::osout." Logging is achieved by using "os::osout" as one would use "std::cout."

template<class dataType > int os::pointerCompareSort (**smart_ptr**< dataType > ptr1, **smart_ptr**< dataType > ptr2)

Raw pointer compare.

Acts as a default comparison function for pointer sorting. Compares the raw pointer values of the two arguements and returns the result.

Parameters

in	*ptr1*	Pointer 1 to compare
in	*ptr2*	Pointer 2 to compare

Returns

1 if greater than, -1 if less than, 0 if equal to

template<class dataType > void os::pointerQuicksort (**smart_ptr**< **smart_ptr**< dataType > > arr, unsigned int length, int(∗)(**smart_ptr**< dataType >, **smart_ptr**< dataType >) sort_comparison = &**pointerCompareSort**)

Template for quick-sort, pointer version.

Preforms quick sort on the provided array of the given length where the array is of pointers to the data type instead of the data type.

Parameters

	[in/out]	array Set of data to be sorted
in	*length*	Length of array to be sorted
in	*sort_comparison*	Comparison function definition

Returns

void

template<class dataType > void os::quicksort (dataType ∗ arr, unsigned int length, int(∗)(const dataType &, const dataType &) sort_comparison = &**defaultCompareSort**)

Template quick-sort.

Preforms quick sort on the provided array of the given length with the given comparison function. The default comparison function is one which uses the comparison operators

Parameters

	[in/out]	array Set of data to be sorted
in	*length*	Length of array to be sorted
in	*sort_comparison*	Comparison function definition

Returns

void

template<class dataType > bool os::testCross (const **matrix**< dataType > & m1, const **matrix**< dataType > & m2)

Tests if the cross-product is a legal operation.

Compares the width of the first matrix versus the height of the second. If the two are equal, the cross-product is defined.

Parameters

in	*m1*	Raw matrix reference
in	*m2*	Raw matrix reference

Returns

True if the cross-product is defined

template<class dataType > bool os::testCross (const **indirectMatrix**< dataType > & m1, const **matrix**< dataType > & m2)

Tests if the cross-product is a legal operation.

Compares the width of the first matrix versus the height of the second. If the two are equal, the cross-product is defined.

Parameters

in	*m1*	Indirect matrix reference
in	*m2*	Raw matrix reference

Returns

True if the cross-product is defined

template<class dataType > bool os::testCross (const **matrix**< dataType > & m1, const **indirectMatrix**< dataType > & m2)

Tests if the cross-product is a legal operation.

Compares the width of the first matrix versus the height of the second. If the two are equal, the cross-product is defined.

Parameters

in	*m1*	Raw matrix reference
in	*m2*	Indirect matrix reference

Returns

True if the cross-product is defined

template<class dataType > bool os::testCross (const **indirectMatrix**< dataType > & m1, const **indirectMatrix**< dataType > & m2)

Tests if the cross-product is a legal operation.

Compares the width of the first matrix versus the height of the second. If the two are equal, the cross-product is defined.

Parameters

in	*m1*	Indirect matrix reference
in	*m2*	Indirect matrix reference

Returns

True if the cross-product is defined

11.1.4 Variable Documentation

std::recursive_mutex* os::eventLock

Event processing mutex.

Locks when events are being created, destroyed, bound or triggered. This allows events to be thread safe. The mutex is declared to be recursive to allow for nested event calls.

smart_ptr<std::ostream> os::oserr_ptr

Standard error pointer for os namespace.

This std::ostream is used as standard error for the os namespace. This pointer can be swapped out to programmatically redirect standard error for the os namespace.

smart_ptr<std::ostream> os::osout_ptr

Standard out pointer for os namespace.

This std::ostream is used as standard out for the os namespace. This pointer can be swapped out to programmatically redirect standard out for the os namespace.

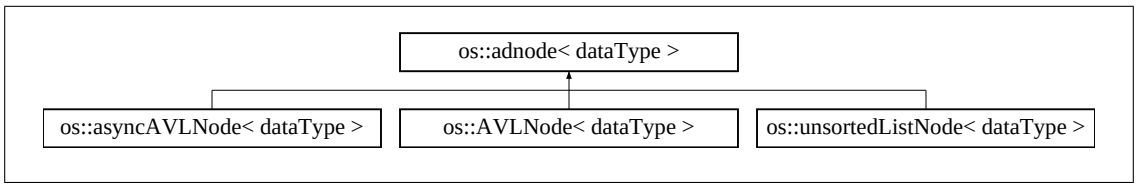
Chapter 12

Class Documentation

12.1 os::adnode< dataType > Class Template Reference

Abstract data-node.

Inheritance diagram for os::adnode< dataType >:



Public Member Functions

- **adnode** (**smart_ptr**< dataType > d)

  Abstract data-node constructor.
- virtual ~**adnode** ()

  Virtual destructor.
- int **compare** (**smart_ptr**< **adnode**< dataType > > inp, bool rawComp=false)

  Compares two abstract data-nodes.
- **smart_ptr**< dataType > & **getData** ()

  Return a reference to the data pointer.
- **smart_ptr**< dataType > & **operator**∗ ()

  Return a reference to the data pointer.
- virtual **smart_ptr**< **adnode**< dataType > > **getNext** ()

  Find the next node.
- virtual **smart_ptr**< **adnode**< dataType > > **getPrev** ()

  Find the previous node.

Protected Attributes

- **smart_ptr**< dataType > **data**

  Data pointer.

12.1.1 Detailed Description

template<class dataType>
class os::adnode< dataType >

Abstract data-node.

A generalized node class used for linked lists, trees, queues and various other abstract data structures. Primarily, this structure is focused on providing access to the node data and allowing traversal of the data-structure.

12.1.2 Constructor & Destructor Documentation

template<class dataType> **os::adnode**< dataType >::**adnode** (**smart_ptr**< dataType > d) `[inline]`

Abstract data-node constructor.

An abstract data-node is meaningless without a pointer to it's dataType. The constructor requires this pointer to initialize the node.

Parameters

`in`	*d*	Data to be bound to the node

template<class dataType> virtual **os::adnode**< dataType >::~**adnode** ( ) `[inline]`, `[virtual]`

Virtual destructor.

Destructor must be virtual, if an object of this type is deleted, the destructor of the type which inherits this class should be called.

12.1.3 Member Function Documentation

template<class dataType> int **os::adnode**< dataType >::compare (**smart_ptr**< **adnode**< dataType > > inp, bool rawComp = `false`) `[inline]`

Compares two abstract data-nodes.

Abstract data nodes use the comparison functions defined by their data pointers to determine their comparison

Parameters

`in`	*inp*	Data-node being compared with

Returns

1, 0, -1 (Greater than, equal to, less than)

template<class dataType> **smart_ptr**<dataType>& **os::adnode**< dataType >::getData ( ) `[inline]`

Return a reference to the data pointer.

Returns

adnode<**datqType**>**::data** (p. 93)

template<class dataType> virtual **smart_ptr**<**adnode**<dataType> > **os::adnode**< dataType >::getNext ( ) `[inline]`, `[virtual]`

Find the next node.

This functions attempts to search for the next node in the structure. By default, or if this node either cannot be found or does not exist, a NULL pointer is returned.

Returns

Pointer to the next node in the structure

Reimplemented in **os::asyncAVLNode**< **dataType** > (p. 100), **os::asyncAVLNode**< **senderType** > (p. 100), **os::asyncAVLNode**< **receiverType** > (p. 100), **os::AVLNode**< **dataType** > (p. 113), and **os::unsortedListNode**< **dataType** > (p. 166).

template<class dataType> virtual **smart_ptr**<**adnode**<dataType> > **os::adnode**< dataType >::getPrev ( ) `[inline]`, `[virtual]`

Find the previous node.

This functions attempts to search for the previous node in the structure. By default, or if this node either cannot be found or does not exist, a NULL pointer is returned.

Returns

Pointer to the previous node in the structure

Reimplemented in **os::AVLNode**< **dataType** > (p. 114), **os::asyncAVLNode**< **dataType** > (p. 100), **os::asyncAVLNode**< **senderType** > (p. 100), **os::asyncAVLNode**< **receiverType** > (p. 100), and **os::unsortedListNode**< **dataType** > (p. 167).

template<class dataType> **smart_ptr**<dataType>& **os::adnode**< dataType >::operator∗ ( ) `[inline]`

Return a reference to the data pointer.

Returns

adnode<**datqType**>**::data** (p. 93)

12.1.4 Member Data Documentation

template<class dataType> **smart_ptr**<dataType> **os::adnode**< dataType >::data `[protected]`

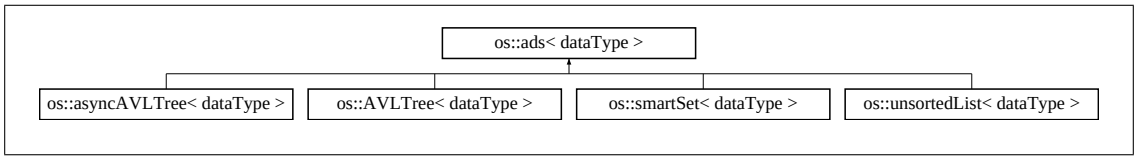
Data pointer.

A pointer to the data being held by the node. This is used to compare nodes as well.

12.2 os::ads< dataType > Class Template Reference

Abstract datastructure.

Inheritance diagram for os::ads< dataType >:



Public Member Functions

- **ads** ()

  Default constructor.
- virtual ~**ads** ()

  Virtual destructor.
- virtual bool **insert** (**smart_ptr**< dataType > x)

  Inserts a data pointer.
- virtual unsigned int **size** () const

  Returns the number of elements in the datastructure.
- virtual **smart_ptr**< **adnode**< dataType > > **find** (**smart_ptr**< dataType > x)

  Finds a matching node.
- virtual bool **findDelete** (**smart_ptr**< dataType > x)

  Finds a matching node and removes it.
- virtual **smart_ptr**< **adnode**< dataType > > **getFirst** ()

  Returns the first node.
- virtual **smart_ptr**< **adnode**< dataType > > **getLast** ()

  Returns the last node.
- virtual bool **insert** (**smart_ptr**< **ads**< dataType > > x)

  Inserts an entire datastructure.
- bool **rawInsert** (**smart_ptr**< dataType > x)

  Inserts a data pointer.
- bool **rawCompare** () const

  Return state of raw compare.
- void **setRawCompare** (bool rwcmp)

  Set raw-compare.

Protected Attributes

- bool **_rawCompare**

  Allows for raw compare data-structures.

12.2.1 Detailed Description

template<class dataType>
class os::ads< dataType >

Abstract datastructure.

A generalized datastructure class which acts as an interface for all datastructures classes. If not extended, the abstract datastructures class is useless.

12.2.2 Constructor & Destructor Documentation

template<class dataType> **os::ads**< dataType >::**ads** ( ) `[inline]`

Default constructor.

This constructor does nothing, as there are no objects to initialize.

template<class dataType> virtual **os::ads**< dataType >::~**ads** ( ) `[inline]`, `[virtual]`

Virtual destructor.

Destructor must be virtual, if an object of this type is deleted, the destructor of the type which inherits this class should be called.

12.2.3 Member Function Documentation

template<class dataType> virtual **smart_ptr**<**adnode**<dataType> > **os::ads**< dataType >::find (**smart_ptr**< dataType > x) `[inline]`, `[virtual]`

Finds a matching node.

Finds a pointer to an object of type "dataType" given a comparison pointer. This comparison function is defined by os::adnode<dataType>::compare(smart_ptr<adnode<dataType> >). Each datastructure which inherits from this class will re-implement this function.

[in] x dataType pointer to be compared against

Returns

The found node if applicable, else NULL

Reimplemented in **os::AVLTree**< **dataType** > (p. 120), **os::asyncAVLTree**< **dataType** > (p. 107), **os::asyncAVLTree**< **senderType** > (p. 107), **os::asyncAVLTree**< **receiverType** > (p. 107), **os::unsortedList**< **dataType** > (p. 163), and **os::smartSet**< **dataType** > (p. 159).

template<class dataType> virtual bool **os::ads**< dataType >::findDelete (**smart_ptr**< dataType > x) [inline], [virtual]

Finds a matching node and removes it.

Finds a pointer to an object of type "dataType" given a comparison pointer. This comparison function is defined by os::adnode<dataType>::compare(smart_ptr<adnode<dataType> >). Each datastructure which inherits from this class will re-implement this function. After finding a node, it will be removed from the datastructure.

[in] x dataType pointer to be compared against

Returns

true if the node was found and deleted, else false

Reimplemented in **os::AVLTree**< **dataType** > (p. 121), **os::asyncAVLTree**< **dataType** > (p. 108), **os::asyncAVLTree**< **senderType** > (p. 108), **os::asyncAVLTree**< **receiverType** > (p. 108), **os::unsortedList**< **dataType** > (p. 163), and **os::smartSet**< **dataType** > (p. 159).

template<class dataType> virtual **smart_ptr**<**adnode**<dataType> > **os::ads**< dataType >::getFirst ( ) [inline], [virtual]

Returns the first node.

Each datastructure has a different definition of what defines "first." By default, this function returns NULL. Datastructures which inherit from this class must re-implement this function.

Returns

The first node, if it exists

Reimplemented in **os::asyncAVLTree**< **dataType** > (p. 109), **os::asyncAVLTree**< **senderType** > (p. 109), **os::asyncAVLTree**< **receiverType** > (p. 109), **os::AVLTree**< **dataType** > (p. 122), **os::unsortedList**< **dataType** > (p. 163), and **os::smartSet**< **dataType** > (p. 159).

template<class dataType> virtual **smart_ptr**<**adnode**<dataType> > **os::ads**< dataType >::getLast ( ) [inline], [virtual]

Returns the last node.

Each datastructure has a different definition of what defines "last." By default, this function returns NULL. Datastructures which inherit from this class must re-implement this function.

Returns

The last node, if it exists

Reimplemented in **os::asyncAVLTree**< **dataType** > (p. 109), **os::asyncAVLTree**< **senderType** > (p. 109), **os::asyncAVLTree**< **receiverType** > (p. 109), **os::AVLTree**< **dataType** > (p. 122), **os::unsortedList**< **dataType** > (p. 164), and **os::smartSet**< **dataType** > (p. 160).

template<class dataType> virtual bool **os::ads**< dataType >::insert (**smart_ptr**< dataType > x) [inline], [virtual]

Inserts a data pointer.

Inserts a pointer to an object of type "dataType." Each datastructure which inherits from this class will re-implement this function

[in] x dataType pointer to be inserted

Returns

true if successful, false if failed

Reimplemented in **os::AVLTree**< **dataType** > (p. 123), **os::asyncAVLTree**< **dataType** > (p. 110), **os::asyncAVLTree**< **senderType** > (p. 110), **os::asyncAVLTree**< **receiverType** > (p. 110), **os::unsortedList**< **dataType** > (p. 164), and **os::smartSet**< **dataType** > (p. 160).

template<class dataType> virtual bool **os::ads**< dataType >::insert (**smart_ptr**< **ads**< dataType > > x) [inline], [virtual]

Inserts an entire datastructure.

This function may be redefined to speed-up insertion. Currently, this function will be O(n * insertionTime) where n is the number of elements in x

[in] x datastructure of type dataType to be inserted

Returns

true if successful, false if failed

Reimplemented in **os::AVLTree**< **dataType** > (p. 123), **os::asyncAVLTree**< **dataType** > (p. 109), **os::asyncAVLTree**< **senderType** > (p. 109), **os::asyncAVLTree**< **receiverType** > (p. 109), **os::unsortedList**< **dataType** > (p. 164), and **os::smartSet**< **dataType** > (p. 160).

template<class dataType> bool **os::ads**< dataType >::rawCompare ( ) const [inline]

Return state of raw compare.

Returns

_rawCompare

template<class dataType> bool **os::ads**< dataType >::rawInsert (**smart_ptr**< dataType > x) [inline]

Inserts a data pointer.

Inserts a pointer to an object of type "dataType." This function disabiguates certain calls to insert.

[in] x dataType pointer to be inserted

Returns

true if successful, false if failed

template<class dataType> void **os::ads**< dataType >::setRawCompare (bool rwcmp) [inline]

Set raw-compare.

Parameters

in	*rwcmp*	Value of raw compare to set

Returns

void

template<class dataType> virtual unsigned int **os::ads**< dataType >::size ( ) const [inline], [virtual]

Returns the number of elements in the datastructure.

This function must be re-implemented by all classes which inherit from this class. By default, this function returns 0.

Returns

number of elements as an unsigned integer

Reimplemented in **os::asyncAVLTree**< **dataType** > (p. 110), **os::asyncAVLTree**< **senderType** > (p. 110), **os::asyncAVLTree**< **receiverType** > (p. 110), **os::AVLTree**< **dataType** > (p. 123), **os::unsortedList**< **dataType** > (p. 164), and **os::smartSet**< **dataType** > (p. 161).

12.2.4 Member Data Documentation

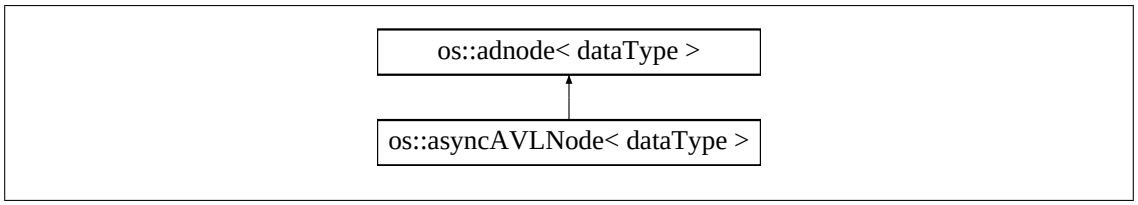
template<class dataType> bool **os::ads**< dataType >::_rawCompare [protected]

Allows for raw compare data-structures.

12.3 os::asyncAVLNode< dataType > Class Template Reference

Node for usage in an asynchronous AVL tree.

Inheritance diagram for os::asyncAVLNode< dataType >:



Public Member Functions

- **asyncAVLNode** (**smart_ptr**< dataType > d, **asyncAVLTree**< dataType > *master)

  Abstract data-node constructor.
- virtual ~**asyncAVLNode** ()

  Virtual destructor.
- **smart_ptr**< **adnode**< dataType > > **getNext** ()

  Find the next node.
- **smart_ptr**< **adnode**< dataType > > **getPrev** ()

  Find the previous node.

Protected Member Functions

- **smart_ptr**< **asyncAVLNode**< dataType > > **getParent** ()

  Returns the parent node.
- **smart_ptr**< **asyncAVLNode**< dataType > > **getChild** (int x)

  Returns a child by index.
- int **getHeight** () const

  Returns the height of the sub-tree.
- void **setHeight** ()

  Sets the height of the sub-tree.
- void **setChild** (**smart_ptr**< **asyncAVLNode**< dataType > > c, bool _rawCompare)

  Add a child to this node.
- void **setParent** (**smart_ptr**< **asyncAVLNode**< dataType > > p, **smart_ptr**< **asyncAVLNode**< dataType > > self_pointer, bool _rawCompare)

  Sets the parent node.
- void **removeChild** (**smart_ptr**< **asyncAVLNode**< dataType > > c, bool _rawCompare)

  Remove a child from this node.
- void **removeChild** (int pos)

  Remove a child from this node.
- void **removeParent** ()

  Remove the parent node.
- void **remove** ()

  Remove all children and parents.

Protected Attributes

- **smart_ptr**< **asyncAVLNode**< dataType > > **parent**

  Parent node one level up in the tree.
- **smart_ptr**< **asyncAVLNode**< dataType > > **child1**

  Left child one level down in the tree.
- **smart_ptr**< **asyncAVLNode**< dataType > > **child2**

  Right child one level down in the tree.
- int **height**

  The height of the tree.
- **asyncAVLTree**< dataType > ∗ **masterTree**

  Reference to source tree.

Friends

- class **asyncAVLTree**< **dataType** >

  AVL Tree must know details of node implementation.

12.3.1 Detailed Description

template<class dataType>
class os::asyncAVLNode< dataType >

Node for usage in an asynchronous AVL tree.

The AVL node class implements a number of functions unique to an AVL tree. This node has knowledge of the structure of the AVL tree through its parent and children.

12.3.2 Constructor & Destructor Documentation

template<class dataType> **os::asyncAVLNode**< dataType >::**asyncAVLNode** (**smart_ptr**< dataType > d, **asyncAVLTree**< dataType > * master) `[inline]`

Abstract data-node constructor.

An AVL node is meaningless without a pointer to it's dataType. The constructor requires this pointer to initialize the node. Parent and children nodes are, by default, initialized to 0.

Parameters

`in`	*d*	Data to be bound to the node

template<class dataType> virtual **os::asyncAVLNode**< dataType >::~**asyncAVLNode** ( ) `[inline]`, `[virtual]`

Virtual destructor.

Destructor must be virtual, if an object of this type is deleted, the destructor of the type which inherits this class should be called.

12.3.3 Member Function Documentation

template<class dataType> **smart_ptr**<**asyncAVLNode**<dataType> > **os::asyncAVLNode**< dataType >::getChild (int x) `[inline]`, `[protected]`

Returns a child by index.

Returns child node by index. 0 indicates the left child, **asyncAVLNode**<**dataType**>**::child1** (p. 102). 1 indicates the right child, **asyncAVLNode**<**dataType**>**::child2** (p. 102). All other indices will return NULL.

Returns

os::asyncAVLNode<**dataType**>**::child1** (p. 102) for x==0, **asyncAVLNode**<**dataType**>**::child2** (p. 102) for x==1

template<class dataType> int **os::asyncAVLNode**< dataType >::getHeight ( ) const `[inline]`, `[protected]`

Returns the height of the sub-tree.

Returns

os::asyncAVLNode<**dataType**>**::height** (p. 103)

template<class dataType> **smart_ptr**<**adnode**<dataType> > **os::asyncAVLNode**< dataType >::getNext ( ) [virtual]

Find the next node.

This functions attempts to search for the next node in the structure. This trips the traverse flag of the current node and traverses the tree looking for the next node.

Returns

Pointer to the next node in the structure

Reimplemented from **os::adnode**< **dataType** > (p. 92).

template<class dataType> **smart_ptr**<**asyncAVLNode**<dataType> > **os::asyncAVLNode**< dataType >::getParent ( ) [inline], [protected]

Returns the parent node.

Returns

os::asyncAVLNode<**dataType**>**::parent** (p. 103)

template<class dataType> **smart_ptr**<**adnode**<dataType> > **os::asyncAVLNode**< dataType >::getPrev ( ) [virtual]

Find the previous node.

This functions attempts to search for the previous node in the structure. This trips the traverse flag of the current node and traverses the tree looking for the previous node.

Returns

Pointer to the previous node in the structure

Reimplemented from **os::adnode**< **dataType** > (p. 92).

template<class dataType> void **os::asyncAVLNode**< dataType >::remove ( ) [inline], [protected]

Remove all children and parents.

This function is important because nodes are of type **os::smart_ptr** (p. 146), since there are co-dependencies, failure to run this function on deletion of the tree will cause a memory leak.

Returns

void

template<class dataType> void **os::asyncAVLNode**< dataType >::removeChild (**smart_ptr**< **asyncAVLNode**< dataType > > c, bool _rawCompare) [inline], [protected]

Remove a child from this node.

Checks **os::asyncAVLNode**<**dataType**>**::child1** (p. 102) and **os::asyncAVLNode**<**dataType**>**::child2** (p. 102) for equality with the the node received as a parameter.

Parameters

in	*c*	Node to be removed

Returns

void

template<class dataType> void **os::asyncAVLNode**< dataType >::removeChild (int pos) [inline], [protected]

Remove a child from this node.

Remove **os::asyncAVLNode**<**dataType**>**::child1** (p. 102) if position is 0 and **os::asyncAVL↩ Node**<**dataType**>**::child2** (p. 102) if position is 1.

Parameters

in	*pos*	Node index to be removed

Returns

void

template<class dataType> void **os::asyncAVLNode**< dataType >::removeParent ( ) [inline], [protected]

Remove the parent node.

Returns

void

template<class dataType> void **os::asyncAVLNode**< dataType >::setChild (**smart_ptr**< **asyncAVLNode**< dataType > > c, bool _rawCompare) [inline], [protected]

Add a child to this node.

Set **os::asyncAVLNode**<**dataType**>**::child1** (p. 102) or **os::asyncAVLNode**<**dataType**>**::child2** (p. 102) based on the comparison of the node to be inserted with the current node.

Parameters

in	*c*	Node to be inserted

Returns

void

template<class dataType> void **os::asyncAVLNode**< dataType >::setHeight ( ) [inline], [protected]

Sets the height of the sub-tree.

Uses the height of the sub-tree of the node's children to calculate the heigh of the sub-tree of this node.

Returns

void

template<class dataType> void **os::asyncAVLNode**< dataType >::setParent (**smart_ptr**< **asyncAVLNode**< dataType > > p, **smart_ptr**< **asyncAVLNode**< dataType > > self_pointer, bool _rawCompare) [inline], [protected]

Sets the parent node.

Sets the parent node of the current node. This function requires a pointer to the current node for memory management.

Parameters

in	*p*	Parent node
in	*self_pointer*	Pointer to self, with memory management

Returns

void

12.3.4 Friends And Related Function Documentation

template<class dataType> friend class **asyncAVLTree**< dataType > [friend]

AVL Tree must know details of node implementation.

Since the AVL node implements many of the unique functions of the AVL tree, the tree must be aware of the private members of it's nodes.

12.3.5 Member Data Documentation

template<class dataType> **smart_ptr**<**asyncAVLNode**<dataType> > **os::asyncAVLNode**< dataType >::child1 [protected]

Left child one level down in the tree.

template<class dataType> **smart_ptr**<**asyncAVLNode**<dataType> > **os::asyncAVLNode**< dataType >::child2 [protected]

Right child one level down in the tree.

template<class dataType> int **os::asyncAVLNode**< dataType >::height [protected]

The height of the tree.

This variable is kept to reduce computation time. It is dependent on the height of a node's children nodes. The **asyncAVLNode**<**dataType**>**::setHeight()** (p. 102) resets the height based on the height of the node's children.

template<class dataType> **asyncAVLTree**<dataType>* **os::asyncAVLNode**< dataType >::masterTree [protected]

Reference to source tree.

This reference to the source tree is used when incrementing or decrementing the node, locking the tree temporarily.

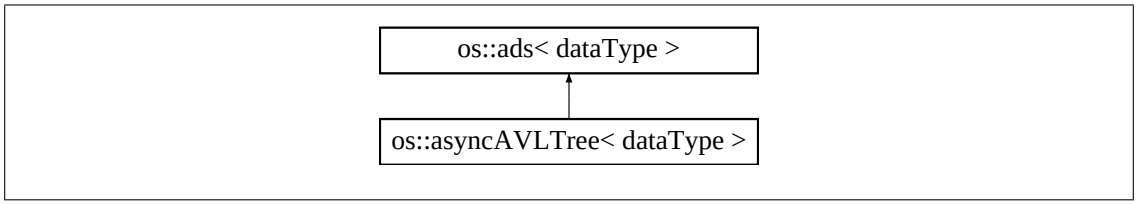
template<class dataType> **smart_ptr**<**asyncAVLNode**<dataType> > **os::asyncAVLNode**< dataType >::parent [protected]

Parent node one level up in the tree.

12.4 os::asyncAVLTree< dataType > Class Template Reference

Asynchronous balanced binary search tree.

Inheritance diagram for os::asyncAVLTree< dataType >:



Public Member Functions

- **asyncAVLTree** ()

  Default constructor.
- virtual ~**asyncAVLTree** ()

  Virtual destructor.
- bool **insert** (**smart_ptr**< **ads**< dataType > > x)

  Inserts an os::ads<dataType>
- bool **insert** (**smart_ptr**< dataType > x)

  Inserts a data node.
- **smart_ptr**< **asyncAVLNode**< dataType > > **getRoot** ()

  Return the root of the tree.
- **smart_ptr**< **adnode**< dataType > > **find** (**smart_ptr**< dataType > x)

  Finds a matching node.
- **smart_ptr**< **adnode**< dataType > > **find** (**smart_ptr**< **adnode**< dataType > > x)

Finds by adnode node.

- **smart_ptr**< **asyncAVLNode**< dataType > > **find** (**smart_ptr**< **asyncAVLNode**< dataType > > x)

  *Finds by **asyncAVLNode** (p. 97) node.*
- bool **findDelete** (**smart_ptr**< dataType > x)

  Finds and delete a matching node.
- bool **findDelete** (long x)

  Finds and delete a matching node.
- bool **findDelete** (**smart_ptr**< **asyncAVLNode**< dataType > > x)

  Finds and delete by node.
- virtual unsigned int **size** () const

  Finds and delete a matching node.
- **smart_ptr**< **adnode**< dataType > > **getFirst** ()

  Returns the first node.
- **smart_ptr**< **adnode**< dataType > > **getLast** ()

  Returns the last node.

Protected Member Functions

- bool **balanceDelete** (**smart_ptr**< **asyncAVLNode**< dataType > > x, bool **_rawCompare**)

  Removes a node and balances the tree.
- bool **checkBalance** (**smart_ptr**< **asyncAVLNode**< dataType > > x)

  Checks if a sub-tree is balanced.
- void **balanceUp** (**smart_ptr**< **asyncAVLNode**< dataType > > x)

  Balances this node and ancestor nodes.
- bool **balance** (**smart_ptr**< **asyncAVLNode**< dataType > > x)

  Balances a single node.
- bool **singleRotation** (**smart_ptr**< **asyncAVLNode**< dataType > > r, int dir)

  Rotates a node.
- bool **doubleRotation** (**smart_ptr**< **asyncAVLNode**< dataType > > r, int dir)

  Double-rotate a node.
- **smart_ptr**< **asyncAVLNode**< dataType > > **findBottom** (**smart_ptr**< **asyncAVLNode**< data↩ Type > > x, int dir)

  Find first or last node in a tree.

Protected Attributes

- **smart_ptr**< **asyncAVLNode**< dataType > > **root**

  Root node of the tree.
- unsigned int **numElements**

  Number of elements in the tree.
- std::mutex **mtx**

  Mutex to ensure synchronous access.

Friends

- class **asyncAVLNode**< **dataType** >

  AVL Node must have access to mutex.

12.4.1 Detailed Description

template<class dataType>
class os::asyncAVLTree< dataType >

Asynchronous balanced binary search tree.

The AVL Tree rigorously balances a binary search tree. As a template class, it can hold any kind of dataType so long as the data type implements basic comparison functions.

12.4.2 Constructor & Destructor Documentation

template<class dataType> **os::asyncAVLTree**< dataType >::**asyncAVLTree** ( ) `[inline]`

Default constructor.

Sets the number of elements to 0 and the root to NULL.

template<class dataType> virtual **os::asyncAVLTree**< dataType >::~**asyncAVLTree** ( ) `[inline]`, `[virtual]`

Virtual destructor.

Destructor must be virtual, if an object of this type is deleted, the destructor of the type which inherits this class should be called. The AVL tree must explicitly force deletion through the **asyncAVLNode**<**dataType**>**::remove()** (p. 100) function.

12.4.3 Member Function Documentation

template<class dataType> bool **os::asyncAVLTree**< dataType >::balance (**smart_ptr**< **asyncAVLNode**< dataType > > x) `[inline]`, `[protected]`

Balances a single node.

Parameters

`in`	*x*	Node to be balanced

Returns

true if the node is already balanced, else, false

template<class dataType> bool **os::asyncAVLTree**< dataType >::balanceDelete (**smart_ptr**< **asyncAVLNode**< dataType > > x, bool _rawCompare) `[inline]`, `[protected]`

Removes a node and balances the tree.

Must receive as an argument a node in the tree. This function removes the node from the tree and re-balances the tree.

Parameters

in	*x*	Node to be deleted

Returns

true if successful, false if failed

template<class dataType> void **os::asyncAVLTree**< dataType >::balanceUp (**smart_ptr**< **asyncAVLNode**< dataType > > x) [inline], [protected]

Balances this node and ancestor nodes.

Balances the current node then orders it's parent node to be balanced as well. This process continues until a node has no parent (indicating the node is the root)

Parameters

in	*x*	Node to be balanced

Returns

void

template<class dataType> bool **os::asyncAVLTree**< dataType >::checkBalance (**smart_ptr**< **asyncAVLNode**< dataType > > x) [inline], [protected]

Checks if a sub-tree is balanced.

Checks if the received node is balanced. This operation is inexpensive as it merely involves comparing the heights of the children nodes.

Parameters

in	*x*	Node to be checked

Returns

true if balanced, false if not

template<class dataType> bool **os::asyncAVLTree**< dataType >::doubleRotation (**smart_ptr**< **asyncAVLNode**< dataType > > r, int dir) [inline], [protected]

Double-rotate a node.

Double-rotates a node based on the dir argument provided. Note that 0 and 1 are the only valid directions.

Parameters

in	*x*	Node to be rotated
in	*dir*	Direction node is to be rotated

Returns

true if successful, else, false

template<class dataType> **smart_ptr**<**adnode**<dataType> > **os::asyncAVLTree**< dataType >::find (**smart_ptr**< dataType > x) [inline], [virtual]

Finds a matching node.

Finds a pointer to an object of type "dataType" given a comparison pointer. This comparison function is defined by os::adnode<dataType>::compare(smart_ptr<adnode<dataType> >). This function takes O(log(n)) where n is the number of elements in the tree.

[in] x dataType pointer to be compared against

Returns

true if the node was found, else false

Reimplemented from **os::ads**< **dataType** > (p. 94).

template<class dataType> **smart_ptr**<**adnode**<dataType> > **os::asyncAVLTree**< dataType >::find (**smart_ptr**< **adnode**< dataType > > x) [inline]

Finds by adnode node.

Finds a pointer to an object of type "dataType" given a comparison pointer to a node. This comparison function is defined by os::adnode<dataType>::compare(smart_ptr<adnode<dataType> >). This function takes O(log(n)) where n is the number of elements in the tree and will re-balance the tree

[in] x os::adnode<dataType> pointer to be compared against

Returns

true if the node was found and deleted, else false

template<class dataType> **smart_ptr**<**asyncAVLNode**<dataType> > **os::asyncAVLTree**< dataType >::find (**smart_ptr**< **asyncAVLNode**< dataType > > x) [inline]

Finds by **asyncAVLNode** (p. 97) node.

Finds a pointer to an object of type "dataType" given a comparison pointer to a node. This comparison function is defined by os::adnode<dataType>::compare(smart_ptr<adnode<dataType> >). This function takes O(log(n)) where n is the number of elements in the tree and will re-balance the tree

[in] x os::asyncAVLNode<dataType> pointer to be compared against

Returns

true if the node was found and deleted, else false

template<class dataType> **smart_ptr**<**asyncAVLNode**<dataType> > **os::asyncAVLTree**< dataType >::findBottom (**smart_ptr**< **asyncAVLNode**< dataType > > x, int dir) [inline], [protected]

Find first or last node in a tree.

Finds the first or last node based on the dir argument provided. Note that 0 and 1 are the only valid directions.

Parameters

in	*x*	Starting node
in	*dir*	Direction node to search in

Returns

First or last node in sub-tree

template<class dataType> bool **os::asyncAVLTree**< dataType >::findDelete (**smart_ptr**< dataType > x) [inline], [virtual]

Finds and delete a matching node.

Finds a pointer to an object of type "dataType" given a comparison pointer and removes it. This comparison function is defined by os::adnode<dataType>::compare(smart_ptr<adnode<dataType> >). This function takes O(log(n)) where n is the number of elements in the tree and will re-balance the tree

[in] x dataType pointer to be compared against

Returns

true if the node was found and deleted, else false

Reimplemented from **os::ads**< **dataType** > (p. 95).

template<class dataType> bool **os::asyncAVLTree**< dataType >::findDelete (long x) [inline]

Finds and delete a matching node.

Finds a pointer to an object of type "dataType" given a comparison pointer and removes it. This comparison function is defined by os::adnode<dataType>::compare(smart_ptr<adnode<dataType> >). This function takes O(log(n)) where n is the number of elements in the tree and will re-balance the tree

[in] x dataType pointer to be compared against

Returns

true if the node was found and deleted, else false

template<class dataType> bool **os::asyncAVLTree**< dataType >::findDelete (**smart_ptr**< **asyncAVLNode**< dataType > > x) [inline]

Finds and delete by node.

Finds a pointer to an object of type "dataType" given a comparison pointer to a node and removes it. This comparison function is defined by os::adnode<dataType>::compare(smart_ptr<adnode<data↩ Type> >). This function takes O(log(n)) where n is the number of elements in the tree and will re-balance the tree

[in] x os::asyncAVLNode<dataType> pointer to be compared against

Returns

true if the node was found and deleted, else false

template<class dataType> **smart_ptr**<**adnode**<dataType> > **os::asyncAVLTree**< dataType >::getFirst ( ) [inline], [virtual]

Returns the first node.

For the AVL tree, the first node is defined as the child at index 1. Note that while an os::adnode<dataType> is returned, the true type of the pointer returned is os::asyncAVLNode<dataType>. This function is O(log(n)).

Returns

The first node, if it exists

Reimplemented from **os::ads**< **dataType** > (p. 95).

template<class dataType> **smart_ptr**<**adnode**<dataType> > **os::asyncAVLTree**< dataType >::getLast ( ) [inline], [virtual]

Returns the last node.

For the AVL tree, the last node is defined as the child at index 0. Note that while an os::adnode<dataType> is returned, the true type of the pointer returned is os::asyncAVLNode<dataType>. This function is O(log(n)).

Returns

The last node, if it exists

Reimplemented from **os::ads**< **dataType** > (p. 95).

template<class dataType> **smart_ptr**<**asyncAVLNode**<dataType> > **os::asyncAVLTree**< dataType >::getRoot ( ) [inline]

Return the root of the tree.

Returns

os::asyncAVLTree<**dataType**>**::root** (p. 111)

template<class dataType> bool **os::asyncAVLTree**< dataType >::insert (**smart_ptr**< **ads**< dataType > > x) [inline], [virtual]

Inserts an os::ads<dataType>

Inserts every element in a given abstract datastructure into this tree. Adopts the insertion function of os::ads<dataType>

[in] x pointer to os::ads<dataType>

Returns

true if successful, false if failed

Reimplemented from **os::ads**< **dataType** > (p. 96).

template<class dataType> bool **os::asyncAVLTree**< dataType >::insert (**smart_ptr**< dataType > x) [inline], [virtual]

Inserts a data node.

Inserts a pointer to an object of type "dataType." This insertion will place the node into the binary tree and balance the tree. This function takes O(log(n)) where n is the number of elements in the tree.

[in] x dataType pointer to be inserted

Returns

true if successful, false if failed

Reimplemented from **os::ads**< **dataType** > (p. 95).

template<class dataType> bool **os::asyncAVLTree**< dataType >::singleRotation (**smart_ptr**< **asyncAVLNode**< dataType > > r, int dir) [inline], [protected]

Rotates a node.

Rotates a node based on the dir argument provided. Note that 0 and 1 are the only valid directions.

Parameters

in	*x*	Node to be rotated
in	*dir*	Direction node is to be rotated

Returns

true if successful, else, false

template<class dataType> virtual unsigned int **os::asyncAVLTree**< dataType >::size ( ) const [inline], [virtual]

Finds and delete a matching node.

Returns

os::asyncAVLTree<**dataType**>**::numElements** (p. 111)

Reimplemented from **os::ads**< **dataType** > (p. 97).

12.4.4 Friends And Related Function Documentation

template<class dataType> friend class **asyncAVLNode**< dataType > [friend]

AVL Node must have access to mutex.

When the **AVLNode** (p. 111) finds the next element or finds the previous element, it must lock the mutex to prevent insertion and deletion into the tree.

12.4.5 Member Data Documentation

template<class dataType> std::mutex **os::asyncAVLTree**< dataType >::mtx `[protected]`

Mutex to ensure synchronous access.

template<class dataType> unsigned int **os::asyncAVLTree**< dataType >::numElements `[protected]`

Number of elements in the tree.

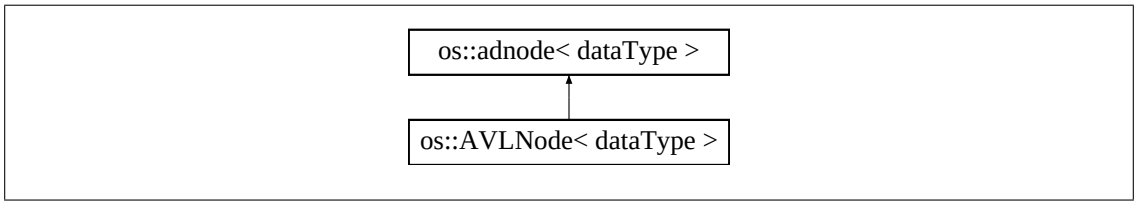
template<class dataType> **smart_ptr**<**asyncAVLNode**<dataType> > **os::asyncAVLTree**< dataType >::root `[protected]`

Root node of the tree.

12.5 os::AVLNode< dataType > Class Template Reference

Node for usage in an AVL tree.

Inheritance diagram for os::AVLNode< dataType >:



Public Member Functions

- **AVLNode** (**smart_ptr**< dataType > d)
  Abstract data-node constructor.
- virtual ~**AVLNode** ()
  Virtual destructor.
- **smart_ptr**< **adnode**< dataType > > **getNext** ()
  Find the next node.
- **smart_ptr**< **adnode**< dataType > > **getPrev** ()
  Find the previous node.

Protected Member Functions

- **smart_ptr**< **AVLNode**< dataType > > **getParent** ()
  Returns the parent node.
- **smart_ptr**< **AVLNode**< dataType > > **getChild** (int x)
  Returns a child by index.
- int **getHeight** () const

Returns the height of the sub-tree.

- void **setHeight** ()

  Sets the height of the sub-tree.
- void **setChild** (**smart_ptr**< **AVLNode**< dataType > > c)

  Add a child to this node.
- void **setParent** (**smart_ptr**< **AVLNode**< dataType > > p, **smart_ptr**< **AVLNode**< dataType > > self_pointer)

  Sets the parent node.
- void **removeChild** (**smart_ptr**< **AVLNode**< dataType > > c)

  Remove a child from this node.
- void **removeChild** (int pos)

  Remove a child from this node.
- void **removeParent** ()

  Remove the parent node.
- void **remove** ()

  Remove all children and parents.

Protected Attributes

- **smart_ptr**< **AVLNode**< dataType > > **parent**

  Parent node one level up in the tree.
- **smart_ptr**< **AVLNode**< dataType > > **child1**

  Left child one level down in the tree.
- **smart_ptr**< **AVLNode**< dataType > > **child2**

  Right child one level down in the tree.
- int **height**

  The height of the tree.

Friends

- class **AVLTree**< **dataType** >

  AVL Tree must know details of node implementation.

12.5.1 Detailed Description

template<class dataType>
class os::AVLNode< dataType >

Node for usage in an AVL tree.

The AVL node class implements a number of functions unique to an AVL tree. This node has knowledge of the structure of the AVL tree through its parent and children.

12.5.2 Constructor & Destructor Documentation

template<class dataType > **os::AVLNode**< dataType >::**AVLNode** (**smart_ptr**< dataType > d) `[inline]`

Abstract data-node constructor.

An AVL node is meaningless without a pointer to it's dataType. The constructor requires this pointer to initialize the node. Parent and children nodes are, by default, initialized to 0.

Parameters

`in`	*d*	Data to be bound to the node

template<class dataType > virtual **os::AVLNode**< dataType >::~**AVLNode** ( ) `[inline]`, `[virtual]`

Virtual destructor.

Destructor must be virtual, if an object of this type is deleted, the destructor of the type which inherits this class should be called.

12.5.3 Member Function Documentation

template<class dataType > **smart_ptr**<**AVLNode**<dataType> > **os::AVLNode**< dataType >::getChild (int x) `[inline]`, `[protected]`

Returns a child by index.

Returns child node by index. 0 indicates the left child, **AVLNode**<**dataType**>**::child1** (p. 116). 1 indicates the right child, **AVLNode**<**dataType**>**::child2** (p. 116). All other indices will return NULL.

Returns

os::AVLNode<**dataType**>**::child1** (p. 116) for x==0, **AVLNode**<**dataType**>**::child2** (p. 116) for x==1

template<class dataType > int **os::AVLNode**< dataType >::getHeight ( ) const `[inline]`, `[protected]`

Returns the height of the sub-tree.

Returns

os::AVLNode<**dataType**>**::height** (p. 116)

template<class dataType > **smart_ptr**<**adnode**<dataType> > **os::AVLNode**< dataType >::getNext ( ) `[inline]`, `[virtual]`

Find the next node.

This functions attempts to search for the next node in the structure. This trips the traverse flag of the current node and traverses the tree looking for the next node.

Returns

Pointer to the next node in the structure

Reimplemented from **os::adnode**< **dataType** > (p. 92).

template<class dataType > **smart_ptr**<**AVLNode**<dataType> > **os::AVLNode**< dataType >::getParent ( ) [inline], [protected]

Returns the parent node.

Returns

os::AVLNode<**dataType**>**::parent** (p. 116)

template<class dataType > **smart_ptr**<**adnode**<dataType> > **os::AVLNode**< dataType >::getPrev ( ) [inline], [virtual]

Find the previous node.

This functions attempts to search for the previous node in the structure. This trips the traverse flag of the current node and traverses the tree looking for the previous node.

Returns

Pointer to the previous node in the structure

Reimplemented from **os::adnode**< **dataType** > (p. 92).

template<class dataType > void **os::AVLNode**< dataType >::remove ( ) [inline], [protected]

Remove all children and parents.

This function is important because nodes are of type **os::smart_ptr** (p. 146), since there are co-dependencies, failure to run this function on deletion of the tree will cause a memory leak.

Returns

void

template<class dataType > void **os::AVLNode**< dataType >::removeChild (**smart_ptr**< **AVLNode**< dataType > > c) [inline], [protected]

Remove a child from this node.

Checks **os::AVLNode**<**dataType**>**::child1** (p. 116) and **os::AVLNode**<**dataType**>**::child2** (p. 116) for equality with the the node received as a parameter.

Parameters

in	*c*	Node to be removed

Returns

void

template<class dataType > void **os::AVLNode**< dataType >::removeChild (int pos) [inline], [protected]

Remove a child from this node.

Remove **os::AVLNode**<**dataType**>**::child1** (p. 116) if position is 0 and **os::AVLNode**<**dataType**>**::child2** (p. 116) if position is 1.

Parameters

in	*pos*	Node index to be removed

Returns

void

template<class dataType > void **os::AVLNode**< dataType >::removeParent ( ) [inline], [protected]

Remove the parent node.

Returns

void

template<class dataType > void **os::AVLNode**< dataType >::setChild (**smart_ptr**< **AVLNode**< dataType > > c) [inline], [protected]

Add a child to this node.

Set **os::AVLNode**<**dataType**>**::child1** (p. 116) or **os::AVLNode**<**dataType**>**::child2** (p. 116) based on the comparison of the node to be inserted with the current node.

Parameters

in	*c*	Node to be inserted

Returns

void

template<class dataType > void **os::AVLNode**< dataType >::setHeight ( ) [inline], [protected]

Sets the height of the sub-tree.

Uses the height of the sub-tree of the node's children to calculate the heigh of the sub-tree of this node.

Returns

void

template<class dataType > void **os::AVLNode**< dataType >::setParent (**smart_ptr**< **AVLNode**< dataType > > p, **smart_ptr**< **AVLNode**< dataType > > self_pointer) [inline], [protected]

Sets the parent node.

Sets the parent node of the current node. This function requires a pointer to the current node for memory management.

Parameters

in	*p*	Parent node
in	*self_pointer*	Pointer to self, with memory management

Returns

void

12.5.4 Friends And Related Function Documentation

template<class dataType > friend class **AVLTree**< dataType > [friend]

AVL Tree must know details of node implementation.

Since the AVL node implements many of the unique functions of the AVL tree, the tree must be aware of the private members of it's nodes.

12.5.5 Member Data Documentation

template<class dataType > **smart_ptr**<**AVLNode**<dataType> > **os::AVLNode**< dataType >::child1 [protected]

Left child one level down in the tree.

template<class dataType > **smart_ptr**<**AVLNode**<dataType> > **os::AVLNode**< dataType >::child2 [protected]

Right child one level down in the tree.

template<class dataType > int **os::AVLNode**< dataType >::height [protected]

The height of the tree.

This variable is kept to reduce computation time. It is dependent on the height of a node's children nodes. The **AVLNode**<**dataType**>**::setHeight()** (p. 115) resets the height based on the height of the node's children.

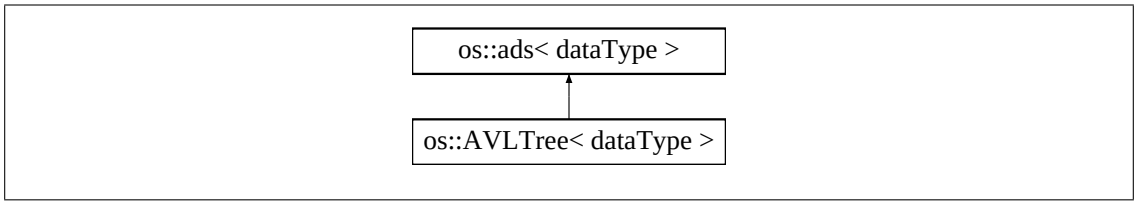
template<class dataType > **smart_ptr**<**AVLNode**<dataType> > **os::AVLNode**< dataType >::parent [protected]

Parent node one level up in the tree.

12.6 os::AVLTree< dataType > Class Template Reference

Balanced binary search tree.

Inheritance diagram for os::AVLTree< dataType >:



Public Member Functions

- **AVLTree** ()

  Default constructor.
- virtual ~**AVLTree** ()

  Virtual destructor.
- bool **insert** (**smart_ptr**< **ads**< dataType > > x)

  Inserts an os::ads<dataType>
- bool **insert** (**smart_ptr**< dataType > x)

  Inserts a data node.
- **smart_ptr**< **AVLNode**< dataType > > **getRoot** ()

  Return the root of the tree.
- **smart_ptr**< **adnode**< dataType > > **find** (**smart_ptr**< dataType > x)

  Finds a matching node.
- **smart_ptr**< **adnode**< dataType > > **find** (**smart_ptr**< **adnode**< dataType > > x)

  Finds by adnode node.
- **smart_ptr**< **AVLNode**< dataType > > **find** (**smart_ptr**< **AVLNode**< dataType > > x)

  *Finds by **AVLNode** (p. 111) node.*
- bool **findDelete** (**smart_ptr**< dataType > x)

  Finds and delete a matching node.
- bool **findDelete** (**smart_ptr**< **AVLNode**< dataType > > x)

  Finds and delete by node.
- virtual unsigned int **size** () const

  Finds and delete a matching node.
- **smart_ptr**< **adnode**< dataType > > **getFirst** ()

  Returns the first node.
- **smart_ptr**< **adnode**< dataType > > **getLast** ()

  Returns the last node.

Protected Member Functions

- bool **balanceDelete** (**smart_ptr**< **AVLNode**< dataType > > x)

  Removes a node and balances the tree.
- bool **checkBalance** (**smart_ptr**< **AVLNode**< dataType > > x)

  Checks if a sub-tree is balanced.
- void **balanceUp** (**smart_ptr**< **AVLNode**< dataType > > x)

  Balances this node and ancestor nodes.
- bool **balance** (**smart_ptr**< **AVLNode**< dataType > > x)

  Balances a single node.
- bool **singleRotation** (**smart_ptr**< **AVLNode**< dataType > > r, int dir)

  Rotates a node.
- bool **doubleRotation** (**smart_ptr**< **AVLNode**< dataType > > r, int dir)

  Double-rotate a node.
- **smart_ptr**< **AVLNode**< dataType > > **findBottom** (**smart_ptr**< **AVLNode**< dataType > > x, int dir)

  Find first or last node in a tree.

Protected Attributes

- **smart_ptr**< **AVLNode**< dataType > > **root**

  Root node of the tree.
- unsigned int **numElements**

  Number of elements in the tree.

12.6.1 Detailed Description

template<class dataType>
class os::AVLTree< dataType >

Balanced binary search tree.

The AVL Tree rigorously balances a binary search tree. As a template class, it can hold any kind of dataType so long as the data type implements basic comparison functions.

12.6.2 Constructor & Destructor Documentation

template<class dataType > **os::AVLTree**< dataType >::**AVLTree** ( ) `[inline]`

Default constructor.

Sets the number of elements to 0 and the root to NULL.

template<class dataType > virtual **os::AVLTree**< dataType >::~**AVLTree** ( ) `[inline]`, `[virtual]`

Virtual destructor.

Destructor must be virtual, if an object of this type is deleted, the destructor of the type which inherits this class should be called. The AVL tree must explicitly force deletion through the **AVL↩ Node**<**dataType**>**::remove()** (p. 114) function.

12.6.3 Member Function Documentation

template<class dataType > bool **os::AVLTree**< dataType >::balance (**smart_ptr**< **AVLNode**< dataType > > x) [inline], [protected]

Balances a single node.

Parameters

in	*x*	Node to be balanced

Returns

true if the node is already balanced, else, false

template<class dataType > bool **os::AVLTree**< dataType >::balanceDelete (**smart_ptr**< **AVLNode**< dataType > > x) [inline], [protected]

Removes a node and balances the tree.

Must receive as an argument a node in the tree. This function removes the node from the tree and re-balances the tree.

Parameters

in	*x*	Node to be deleted

Returns

true if successful, false if failed

template<class dataType > void **os::AVLTree**< dataType >::balanceUp (**smart_ptr**< **AVLNode**< dataType > > x) [inline], [protected]

Balances this node and ancestor nodes.

Balances the current node then orders it's parent node to be balanced as well. This process continues until a node has no parent (indicating the node is the root)

Parameters

in	*x*	Node to be balanced

Returns

void

template<class dataType > bool **os::AVLTree**< dataType >::checkBalance (**smart_ptr**< **AVLNode**< dataType > > x) [inline], [protected]

Checks if a sub-tree is balanced.

Checks if the received node is balanced. This operation is inexpensive as it merely involves comparing the heights of the children nodes.

Parameters

in	*x*	Node to be checked

Returns

true if balanced, false if not

template<class dataType > bool **os::AVLTree**< dataType >::doubleRotation (**smart_ptr**< **AVLNode**< dataType > > r, int dir) [inline], [protected]

Double-rotate a node.

Double-rotates a node based on the dir argument provided. Note that 0 and 1 are the only valid directions.

Parameters

in	*x*	Node to be rotated
in	*dir*	Direction node is to be rotated

Returns

true if successful, else, false

template<class dataType > **smart_ptr**<**adnode**<dataType> > **os::AVLTree**< dataType >::find (**smart_ptr**< dataType > x) [inline], [virtual]

Finds a matching node.

Finds a pointer to an object of type "dataType" given a comparison pointer. This comparison function is defined by os::adnode<dataType>::compare(smart_ptr<adnode<dataType> >). This function takes O(log(n)) where n is the number of elements in the tree.

[in] x dataType pointer to be compared against

Returns

true if the node was found, else false

Reimplemented from **os::ads**< **dataType** > (p. 94).

template<class dataType > **smart_ptr**<**adnode**<dataType> > **os::AVLTree**< dataType >::find (**smart_ptr**< **adnode**< dataType > > x) [inline]

Finds by adnode node.

Finds a pointer to an object of type "dataType" given a comparison pointer to a node. This comparison function is defined by os::adnode<dataType>::compare(smart_ptr<adnode<dataType> >). This function takes O(log(n)) where n is the number of elements in the tree and will re-balance the tree

[in] x os::adnode<dataType> pointer to be compared against

Returns

true if the node was found and deleted, else false

template<class dataType > **smart_ptr**<**AVLNode**<dataType> > **os::AVLTree**< dataType >::find (**smart_ptr**< **AVLNode**< dataType > > x) [inline]

Finds by **AVLNode** (p. 111) node.

Finds a pointer to an object of type "dataType" given a comparison pointer to a node. This comparison function is defined by os::adnode<dataType>::compare(smart_ptr<adnode<dataType> >). This function takes O(log(n)) where n is the number of elements in the tree and will re-balance the tree

[in] x os::AVLNode<dataType> pointer to be compared against

Returns

true if the node was found and deleted, else false

template<class dataType > **smart_ptr**<**AVLNode**<dataType> > **os::AVLTree**< dataType >::findBottom (**smart_ptr**< **AVLNode**< dataType > > x, int dir) [inline], [protected]

Find first or last node in a tree.

Finds the first or last node based on the dir argument provided. Note that 0 and 1 are the only valid directions.

Parameters

in	*x*	Starting node
in	*dir*	Direction node to search in

Returns

First or last node in sub-tree

template<class dataType > bool **os::AVLTree**< dataType >::findDelete (**smart_ptr**< dataType > x) [inline], [virtual]

Finds and delete a matching node.

Finds a pointer to an object of type "dataType" given a comparison pointer and removes it. This comparison function is defined by os::adnode<dataType>::compare(smart_ptr<adnode<dataType> >). This function takes O(log(n)) where n is the number of elements in the tree and will re-balance the tree

[in] x dataType pointer to be compared against

Returns

true if the node was found and deleted, else false

Reimplemented from **os::ads**< **dataType** > (p. 95).

template<class dataType > bool **os::AVLTree**< dataType >::findDelete (**smart_ptr**< **AVLNode**< dataType > > x) [inline]

Finds and delete by node.

Finds a pointer to an object of type "dataType" given a comparison pointer to a node and removes it. This comparison function is defined by os::adnode<dataType>::compare(smart_ptr<adnode<data↩ Type> >). This function takes O(log(n)) where n is the number of elements in the tree and will re-balance the tree

[in] x os::AVLNode<dataType> pointer to be compared against

Returns

true if the node was found and deleted, else false

template<class dataType > **smart_ptr**<**adnode**<dataType> > **os::AVLTree**< dataType >::getFirst ( ) [inline], [virtual]

Returns the first node.

For the AVL tree, the first node is defined as the child at index 1. Note that while an os↩ ::adnode<dataType> is returned, the true type of the pointer returned is os::AVLNode<dataType>. This function is O(log(n)).

Returns

The first node, if it exists

Reimplemented from **os::ads**< **dataType** > (p. 95).

template<class dataType > **smart_ptr**<**adnode**<dataType> > **os::AVLTree**< dataType >::getLast ( ) [inline], [virtual]

Returns the last node.

For the AVL tree, the last node is defined as the child at index 0. Note that while an os↩ ::adnode<dataType> is returned, the true type of the pointer returned is os::AVLNode<dataType>. This function is O(log(n)).

Returns

The last node, if it exists

Reimplemented from **os::ads**< **dataType** > (p. 95).

template<class dataType > **smart_ptr**<**AVLNode**<dataType> > **os::AVLTree**< dataType >::getRoot ( ) [inline]

Return the root of the tree.

Returns

os::AVLTree<**dataType**>**::root** (p. 124)

template<class dataType > bool **os::AVLTree**< dataType >::insert (**smart_ptr**< **ads**< dataType > > x) [inline], [virtual]

Inserts an os::ads<dataType>

Inserts every element in a given abstract datastructure into this tree. Adopts the insertion function of os::ads<dataType>

[in] x pointer to os::ads<dataType>

Returns

true if successful, false if failed

Reimplemented from **os::ads**< **dataType** > (p. 96).

template<class dataType > bool **os::AVLTree**< dataType >::insert (**smart_ptr**< dataType > x) [inline], [virtual]

Inserts a data node.

Inserts a pointer to an object of type "dataType." This insertion will place the node into the binary tree and balance the tree. This function takes O(log(n)) where n is the number of elements in the tree.

[in] x dataType pointer to be inserted

Returns

true if successful, false if failed

Reimplemented from **os::ads**< **dataType** > (p. 95).

template<class dataType > bool **os::AVLTree**< dataType >::singleRotation (**smart_ptr**< **AVLNode**< dataType > > r, int dir) [inline], [protected]

Rotates a node.

Rotates a node based on the dir argument provided. Note that 0 and 1 are the only valid directions.

Parameters

in	*x*	Node to be rotated
in	*dir*	Direction node is to be rotated

Returns

true if successful, else, false

template<class dataType > virtual unsigned int **os::AVLTree**< dataType >::size ( ) const [inline], [virtual]

Finds and delete a matching node.

Returns

os::AVLTree<**dataType**>**::numElements** (p. 124)

Reimplemented from **os::ads**< **dataType** > (p. 97).

12.6.4 Member Data Documentation

template<class dataType > unsigned int **os::AVLTree**< dataType >::numElements `[protected]`

Number of elements in the tree.

template<class dataType > **smart_ptr**<**AVLNode**<dataType> > **os::AVLTree**< dataType >::root `[protected]`

Root node of the tree.

12.7 os::constantPrinter Class Reference

Prints constant arrays to files.

Public Member Functions

- **constantPrinter** (std::string fileName, bool has_cpp=false)
  Single constructor.
- virtual ~**constantPrinter** ()
  Virtual destructor.
- void **addInclude** (std::string includeName)
  Add include file.
- void **addNamespace** (std::string namesp)
  Add a namespace.
- void **removeNamespace** ()
  Remove namespace.
- void **addComment** (std::string comment)
  Insert a comment.
- bool **hasCPP** () const
  Returns if the object is writing to a .cpp file.
- bool **good** () const
  Checks file status.
- void **addArray** (std::string name, uint32_t ∗arr, unsigned int length)
  Add a uin32_t∗ array.

Private Member Functions

- std::string **capitalize** (std::string str) const
  Capitalizes the string argument.
- std::string **tabs** () const
  Returns current tab depth.

Private Attributes

- std::ofstream **hFile**

  Output file for the .h file.
- std::ofstream **cppFile**

  Output file for the .cpp file.
- bool **_has_cpp**

  Holds if the object is generating a .cpp.
- unsigned int **namespaceDepth**

  Current namespace depth.

12.7.1 Detailed Description

Prints constant arrays to files.

This class outputs configured and populated constant arrays into .h and .cpp files, depending on the configuration. This class is meant to be used as a tool for automatically generating source code files.

12.7.2 Constructor & Destructor Documentation

os::constantPrinter::constantPrinter (std::string fileName, bool has_cpp = `false`)

Single constructor.

Creates a file of "filename.h" and, if has_cpp is set to "true," "filename.cpp" with appropriate include guards and a comment indicating the source of the file.

Parameters

`in`	*fileName*	String representing the file name
`in`	*has_cpp*	Optional boolean defining if a .cpp will be written

virtual os::constantPrinter::~constantPrinter ( ) `[virtual]`

Virtual destructor.

Closes all namespaces and #ifdefs, closes the .h file and .cpp if appropriate.

12.7.3 Member Function Documentation

void os::constantPrinter::addArray (std::string name, uint32_t * arr, unsigned int length)

Add a uin32_t* array.

Added an unsigned 32 bit integer array to the .h and .cpp file. Note that this array will be declared as constant.

Parameters

`in`	*arr*	Array to be written to the files

Parameters

in	*length*	Length of the received array

Returns

void

void os::constantPrinter::addComment (std::string comment)

Insert a comment.

Adds a comment. If the comment is a single line, '//' will be used, otherwise, a standard multi-line comment format will be used.

Parameters

in	*comment*	Comment string to be added as a comment

Returns

void

void os::constantPrinter::addInclude (std::string includeName)

Add include file.

Prints out "#include includeName" to the .h file. Since the .cpp file includes the .h file, it will include all of the .h file's includes

Parameters

in	*includeName*	Name of header file to be included

Returns

void

void os::constantPrinter::addNamespace (std::string namesp)

Add a namespace.

Adds a new namespace. Namespaces nest, so this function increments **constantPrinter↩ ::namespaceDepth** (p. 128). Both the .h and .cpp file have this namespace added.

Parameters

in	*namesp*	Namespace added to the file

Returns

void

std::string os::constantPrinter::capitalize (std::string str) const [private]

Capitalizes the string argument.

Primarily used for #ifdef and #define include guards, this function returns the string it is passed but with every single letter capitalized.

Parameters

in	*str*	String to be capitalized

Returns

std::string with each letter capitalized

bool os::constantPrinter::good ( ) const [inline]

Checks file status.

Checks to ensure that both the .h and .cpp file can be written to. Will not consider the .cpp file if the .cpp file is not being written to.

Returns

file status

bool os::constantPrinter::hasCPP ( ) const [inline]

Returns if the object is writing to a .cpp file.

Returns

constantPrinter::_has_cpp (p. 128)

void os::constantPrinter::removeNamespace ( )

Remove namespace.

Ends the current namespace with a '}' in both the .h and .cpp file. Decrements **constantPrinter::namespaceDepth** (p. 128).

Returns

void

std::string os::constantPrinter::tabs ( ) const [private]

Returns current tab depth.

Again used to streamline large projects. This function returns an std::string with tab characters equal to the current number of nested namespaces.

Returns

std::string containing **os::constantPrinter::namespaceDepth** (p. 128) tabs

12.7.4 Member Data Documentation

bool os::constantPrinter::_has_cpp [private]

Holds if the object is generating a .cpp.

std::ofstream os::constantPrinter::cppFile [private]

Output file for the .cpp file.

std::ofstream os::constantPrinter::hFile [private]

Output file for the .h file.

unsigned int os::constantPrinter::namespaceDepth [private]

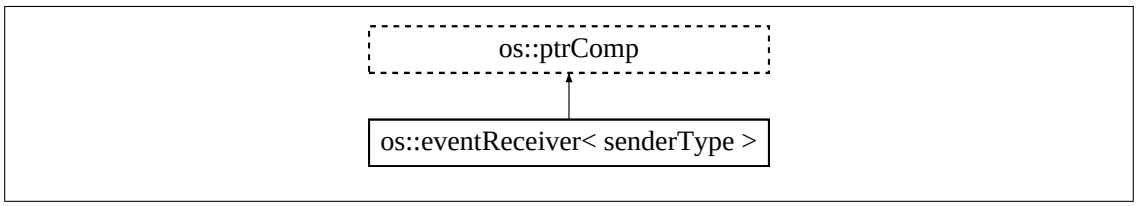
Current namespace depth.

In order to streamline large projects, arrays of constants should be placed inside namespaces. This variable allows for the creation and management of nested namespaces.

12.8 os::eventReceiver< senderType > Class Template Reference

Class which enables event receiving.

Inheritance diagram for os::eventReceiver< senderType >:



Public Member Functions

- **eventReceiver** ()

  Default constructor.
- virtual ~**eventReceiver** ()

  Virtual destructor.
- void **pushSender** (**smart_ptr**< senderType > ptr)

  Add a sender to the list.
- void **removeSender** (**smart_ptr**< senderType > ptr)

  Remove sender from the sender list.

Private Member Functions

- virtual void **receiveEvent** (**smart_ptr**< senderType > src)

  Receive event notification.

Private Attributes

- **asyncAVLTree**< senderType > **senders**

  List of sender.

Friends

- template<typename receiverType >
  class **eventSender**

12.8.1 Detailed Description

template<class senderType>
class os::eventReceiver< senderType >

Class which enables event receiving.

Each receiver contains a list of senders. When the receiver is destroyed, it removes itself from all senders to which it is registered.

12.8.2 Constructor & Destructor Documentation

template<class senderType > **os::eventReceiver**< senderType >::**eventReceiver** ( ) `[inline]`

Default constructor.

The default constructor for the smart set configures the only data type in this class properly. No additional constructor arguments are required.

template<class senderType > virtual **os::eventReceiver**< senderType >::~**eventReceiver** ( ) `[virtual]`

Virtual destructor.

Destructor must be virtual, if an object of this type is deleted, the destructor of the type which inherits this class should be called.

12.8.3 Member Function Documentation

template<class senderType > void **os::eventReceiver**< senderType >::pushSender (**smart_ptr**< senderType > ptr)

Add a sender to the list.

Adds a sender of the sender type expected by this receiver type. Note that the sender type is expected to inherit from **os::eventSender** (p. 131).

Parameters

ptr	Sender to be added to the set

Returns

void

template<class senderType > virtual void **os::eventReceiver**< senderType >::receiveEvent (**smart_ptr**< senderType > src) [inline], [private], [virtual]

Receive event notification.

This function is meant to be reimplemented by all event receivers to do some action on the event.

Parameters

src	The source of the event

Returns

void

template<class senderType > void **os::eventReceiver**< senderType >::removeSender (**smart_ptr**< senderType > ptr)

Remove sender from the sender list.

Removes a sender from the sender list. Note that this also removes this receiver from the receiver list of the sender which it is passed.

Parameters

ptr	Sender to be removed to the set

Returns

void

12.8.4 Friends And Related Function Documentation

template<class senderType > template<typename receiverType > friend class **eventSender** [friend]

The sender must be able to remove itself from the private senders list inside the event receiver. Additionally, the sender must be able to send an event to the receiver.

12.8.5 Member Data Documentation

template<class senderType > **asyncAVLTree**<senderType> **os::eventReceiver**< senderType >::senders `[private]`

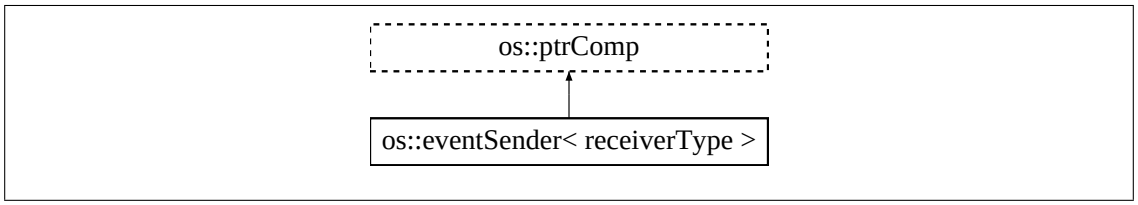
List of sender.

When the receiver is destroyed, this list is used to remove itself from all its senders.

12.9 os::eventSender< receiverType > Class Template Reference

Class which enables event sending.

Inheritance diagram for os::eventSender< receiverType >:



Public Member Functions

- **eventSender** ()

  Default constructor.
- virtual ~**eventSender** ()

  Virtual destructor.
- void **pushReceivers** (**smart_ptr**< receiverType > ptr)

  Add a receiver to the list.
- void **removeReceivers** (**smart_ptr**< receiverType > ptr)

  Remove receiver from the receiver list.

Protected Member Functions

- virtual void **sendEvent** (**smart_ptr**< receiverType > ptr)

  Receive event notification.
- void **triggerEvent** ()

  Sends an event to all receivers.

Private Attributes

- **asyncAVLTree**< receiverType > **receivers**

  List of receivers.

Friends

- template<typename senderType >
  class **eventReceiver**

12.9.1 Detailed Description

template<class receiverType>
class os::eventSender< receiverType >

Class which enables event sending.

Each sender contains a list of receivers. When an event is triggered, the sender iterates through the list to send the event to all receivers.

12.9.2 Constructor & Destructor Documentation

template<class receiverType > **os::eventSender**< receiverType >::**eventSender** ( ) `[inline]`

Default constructor.

The default constructor for the smart set configures the only data type in this class properly. No additional constructor arguments are required.

template<class receiverType > virtual **os::eventSender**< receiverType >::~**eventSender** ( )
`[virtual]`

Virtual destructor.

Destructor must be virtual, if an object of this type is deleted, the destructor of the type which inherits this class should be called.

12.9.3 Member Function Documentation

template<class receiverType > void **os::eventSender**< receiverType >::pushReceivers (
smart_ptr< receiverType > ptr)

Add a receiver to the list.

Adds a receiver of the receiver type expected by this sender type. Note that the receiver type is expected to inherit from **os::eventReceiver** (p. 128).

Parameters

ptr	Receiver to be added to the set

Returns

void

template<class receiverType > void **os::eventSender**< receiverType >::removeReceivers (
smart_ptr< receiverType > ptr)

Remove receiver from the receiver list.

Removes a receiver from the receiver list. Note that this also removes this sender from the sender list of the receiver which it is passed.

Parameters

ptr	Receiver to be removed to the set

Returns

void

template<class receiverType > virtual void **os::eventSender**< receiverType >::sendEvent (**smart_ptr**< receiverType > ptr) [protected], [virtual]

Receive event notification.

This function can be re-implemented by event senders. This function allows some function other than "receiveEvent" to be sent by the event sender to an event receiver.

Parameters

ptr	The target of the event

Returns

void

template<class receiverType > void **os::eventSender**< receiverType >::triggerEvent ( ) [protected]

Sends an event to all receivers.

Iterates through the set of receivers and sends an event to each one. This calls the **os::event↩ Sender**<**receiverType**>**::sendEvent** (p. 133) function with each receiver as an argument.

Returns

void

12.9.4 Friends And Related Function Documentation

template<class receiverType > template<typename senderType > friend class **eventReceiver** [friend]

The receiver must be able to remove itself from the private receivers list inside the event sender.

12.9.5 Member Data Documentation

template<class receiverType > **asyncAVLTree**<receiverType> **os::eventSender**< receiverType >::receivers [private]

List of receivers.

This list is used to send events to all receivers. When the sender is destroyed, it must remove itself from all its receivers.

12.10 os::indirectMatrix< dataType > Class Template Reference

Indirect matrix.

Public Member Functions

- **indirectMatrix** (uint32_t w=0, uint32_t h=0)

  Default constructor.
- **indirectMatrix** (const **matrix**< dataType > &m)

  Copy constructor.
- **indirectMatrix** (const **indirectMatrix**< dataType > &m)

  Copy constructor.
- **indirectMatrix** (const **smart_ptr**< dataType > d, uint32_t w, uint32_t h)

  Data array constructor.
- **indirectMatrix** (**smart_ptr**< **smart_ptr**< dataType > > d, uint32_t w, uint32_t h)

  Indirect data array constructor.
- virtual ~**indirectMatrix** ()

  Virtual destructor.
- **indirectMatrix**< dataType > & **operator=** (const **matrix**< dataType > &m)

  Equality constructor.
- **indirectMatrix**< dataType > & **operator=** (const **indirectMatrix**< dataType > &m)

  Equality constructor.
- **smart_ptr**< dataType > & **get** (uint32_t w, uint32_t h)

  Return pointer to a matrix element.
- const **smart_ptr**< dataType > & **constGet** (uint32_t w, uint32_t h) const

  Return constant pointer to a matrix element.
- **smart_ptr**< dataType > & **operator()** (uint32_t w, uint32_t h)

  Return pointer to a matrix element.
- **smart_ptr**< **smart_ptr**< dataType > > **getArray** ()

  Return pointer to the pointer array.
- const **smart_ptr**< **smart_ptr**< dataType > > **getConstArray** () const

  Return a constant pointer to the pointer array.
- uint32_t **getWidth** () const

  Return width of matrix.
- uint32_t **getHeight** () const

  Return height of matrix.

Private Attributes

- uint32_t **width**

  Width of the matrix.
- uint32_t **height**

  Height of the matrix.
- **smart_ptr**< **smart_ptr**< dataType > > **data**

  Data array pointers.

Friends

- class **matrix**< **dataType** >

  Raw matrix interacting with indirect matrix.

12.10.1 Detailed Description

template<class dataType>
class os::indirectMatrix< dataType >

Indirect matrix.

This matrix class contains an array to pointers of the data type. It can interact with os::matrix<data↩Type>.

12.10.2 Constructor & Destructor Documentation

template<class dataType> **os::indirectMatrix**< dataType >::**indirectMatrix** (uint32_t w = `0`, uint32_t h = `0`)

Default constructor.

Constructs array of size w∗h and sets all of the data to 0. If no width and height are provided, the data array is not initialized.

Parameters

`in`	*w*	Width of matrix, default 0
`in`	*h*	Height of matrix, default 0

template<class dataType> **os::indirectMatrix**< dataType >::**indirectMatrix** (const **matrix**< dataType > & m)

Copy constructor.

Constructs a new indirect matrix from the given raw matrix. The indirect matrix converts the array of object to an array of pointers.

Parameters

`in`	*m*	Indirect matrix to be copied

template<class dataType> **os::indirectMatrix**< dataType >::**indirectMatrix** (const **indirectMatrix**< dataType > & m)

Copy constructor.

Constructs a new indirect matrix from the given indirect matrix. The two indirect matrices do not share data array, the new indirect matrix builds its own array.

Parameters

in	*m*	Indirect matrix to be copied

template<class dataType> **os::indirectMatrix**< dataType >::**indirectMatrix** (const **smart_ptr**< dataType > d, uint32_t w, uint32_t h)

Data array constructor.

Constructs a new indirect matrix from an array of the correct data type. This constructor will build an new indirect array based on the specified size.

Parameters

in	*d*	Data array to be copied
in	*w*	Width of matrix
in	*d*	Height of matrix

template<class dataType> **os::indirectMatrix**< dataType >::**indirectMatrix** (**smart_ptr**< **smart_ptr**< dataType > > d, uint32_t w, uint32_t h)

Indirect data array constructor.

Constructs a new indirect matrix from an indirect array of the correct data type. This constructor will build an new indirect array based on the specified size.

Parameters

in	*d*	Indirect data array to be copied
in	*w*	Width of matrix
in	*d*	Height of matrix

template<class dataType> virtual **os::indirectMatrix**< dataType >::~**indirectMatrix** ( ) [inline], [virtual]

Virtual destructor.

Destructor must be virtual, if an object of this type is deleted, the destructor of the type which inherits this class should be called.

12.10.3 Member Function Documentation

template<class dataType> const **smart_ptr**<dataType>& **os::indirectMatrix**< dataType >::constGet (uint32_t w, uint32_t h) const

Return constant pointer to a matrix element.

Uses a width and height position to index an element of the array. This function returns a constant reference, meaning changes cannot be made to the matrix.

Parameters

in	*w*	X position
in	*h*	Y position

Returns

Constant reference to matrix element pointer

template<class dataType> **smart_ptr**<dataType>& **os::indirectMatrix**< dataType >::get (uint32_t w, uint32_t h)

Return pointer to a matrix element.

Uses a width and height position to index an element of the array. This function returns a reference, allowing for changes to be made to the matrix.

Parameters

in	*w*	X position
in	*h*	Y position

Returns

Modifiable reference to matrix element pointer

template<class dataType> **smart_ptr**<**smart_ptr**<dataType> > **os::indirectMatrix**< dataType >::getArray ( ) `[inline]`

Return pointer to the pointer array.

The array which is returned allows for modification of the array. It is up to functions using this array to ensure the integrity of the indirect matrix.

Returns

os::indirectMatrix<**dataType**>**::data** (p. 139)

template<class dataType> const **smart_ptr**<**smart_ptr**<dataType> > **os::indirectMatrix**< dataType >::getConstArray ( ) const `[inline]`

Return a constant pointer to the pointer array.

The array which is returned allows for access to the array. The provided array may not be modified.

Returns

os::indirectMatrix<**dataType**>**::data** (p. 139)

template<class dataType> uint32_t **os::indirectMatrix**< dataType >::getHeight ( ) const `[inline]`

Return height of matrix.

Returns

indirectMatrix<**dataType**>**::height** (p. 139)

template<class dataType> uint32_t **os::indirectMatrix**< dataType >::getWidth ( ) const `[inline]`

Return width of matrix.

Returns

indirectMatrix<**dataType**>**::width** (p. 139)

template<class dataType> **smart_ptr**<dataType>& **os::indirectMatrix**< dataType >::operator() (uint32_t w, uint32_t h) `[inline]`

Return pointer to a matrix element.

Uses a width and height position to index an element of the array. This function returns a reference, allowing for changes to be made to the matrix.

Parameters

`in`	*w*	X position
`in`	*h*	Y position

Returns

Modifiable reference to matrix element pointer

template<class dataType> **indirectMatrix**<dataType>& **os::indirectMatrix**< dataType >::operator= (const **matrix**< dataType > & m)

Equality constructor.

Re-constructs the indirect matrix from a raw matrix. Note that the two matrices do not share the same data array.

Parameters

`in`	*m*	Reference to matrix being copied

Returns

Reference to self

template<class dataType> **indirectMatrix**<dataType>& **os::indirectMatrix**< dataType >::operator= (const **indirectMatrix**< dataType > & m)

Equality constructor.

Re-constructs the indirect matrix from another indirect matrix. Note that the two matrices do not share the same data array.

Parameters

in	*m*	Reference to matrix being copied

Returns

Reference to self

12.10.4 Friends And Related Function Documentation

template<class dataType> friend class **matrix**< dataType > [friend]

Raw matrix interacting with indirect matrix.

The os::matrix<dataType> class must be able to access the size and data of the indirect matrix because and raw matrix can be constructed from an indirect matrix.

12.10.5 Member Data Documentation

template<class dataType> **smart_ptr**<**smart_ptr**<dataType> > **os::indirectMatrix**< dataType >::data [private]

Data array pointers.

For the indirect matrix class, this array contains pointers to all of the data used by the matrix in a block of size width∗height.

template<class dataType> uint32_t **os::indirectMatrix**< dataType >::height [private]

Height of the matrix.

template<class dataType> uint32_t **os::indirectMatrix**< dataType >::width [private]

Width of the matrix.

12.11 os::matrix< dataType > Class Template Reference

Raw matrix.

Public Member Functions

- **matrix** (uint32_t w=0, uint32_t h=0)

  Default constructor.
- **matrix** (const **matrix**< dataType > &m)

  Copy constructor.
- **matrix** (const **indirectMatrix**< dataType > &m)

  Copy constructor.
- **matrix** (const **smart_ptr**< dataType > d, uint32_t w, uint32_t h)

  Data array constructor.

- **matrix** (**smart_ptr**< **smart_ptr**< dataType > > d, uint32_t w, uint32_t h)

  Indirect data array constructor.
- virtual ~**matrix** ()

  Virtual destructor.
- **matrix**< dataType > & **operator=** (const **matrix**< dataType > &m)

  Equality constructor.
- **matrix**< dataType > & **operator=** (const **indirectMatrix**< dataType > &m)

  Equality constructor.
- dataType & **get** (uint32_t w, uint32_t h)

  Return matrix element.
- const dataType & **constGet** (uint32_t w, uint32_t h) const

  Return constant matrix element.
- dataType & **operator()** (uint32_t w, uint32_t h)

  Return matrix element.
- **smart_ptr**< dataType > **getArray** ()

  Return pointer to the array.
- const **smart_ptr**< dataType > **getConstArray** () const

  Return a constant pointer to the array.
- uint32_t **getWidth** () const

  Return width of matrix.
- uint32_t **getHeight** () const

  Return height of matrix.

Private Attributes

- uint32_t **width**

  Width of the matrix.
- uint32_t **height**

  Height of the matrix.
- **smart_ptr**< dataType > **data**

  Data array.

Friends

- class **indirectMatrix**< **dataType** >

  Indirect matrix interacting with raw matrix.

12.11.1 Detailed Description

template<class dataType>
class os::matrix< dataType >

Raw matrix.

This matrix class contains an array of the data type. It can interact with os::indirectMatrix<data↩ Type>.

12.11.2 Constructor & Destructor Documentation

template<class dataType> **os::matrix**< dataType >::**matrix** (uint32_t w = 0, uint32_t h = 0)

Default constructor.

Constructs array of size w∗h and sets all of the data to 0. If no width and height are provided, the data array is not initialized.

Parameters

in	*w*	Width of matrix, default 0
in	*h*	Height of matrix, default 0

template<class dataType> **os::matrix**< dataType >::**matrix** (const **matrix**< dataType > & m)

Copy constructor.

Constructs a new raw matrix from the given raw matrix. The two matrices do not share the same data array.

Parameters

in	*m*	Matrix to be copied

template<class dataType> **os::matrix**< dataType >::**matrix** (const **indirectMatrix**< dataType > & m)

Copy constructor.

Constructs a new raw matrix from the given indirect matrix. The raw matrix converts the array of pointers to an array of objects

Parameters

in	*m*	Indirect matrix to be copied

template<class dataType> **os::matrix**< dataType >::**matrix** (const **smart_ptr**< dataType > d, uint32_t w, uint32_t h)

Data array constructor.

Constructs a new raw matrix from an array of the correct data type. This constructor will build an new array based on the specified size.

Parameters

in	*d*	Data array to be copied
in	*w*	Width of matrix
in	*d*	Height of matrix

template<class dataType> **os::matrix**< dataType >::**matrix** (**smart_ptr**< **smart_ptr**< dataType > > d, uint32_t w, uint32_t h)

Indirect data array constructor.

Constructs a new raw matrix from an indirect array of the correct data type. This constructor will build an new array based on the specified size.

Parameters

in	*d*	Indirect data array to be copied
in	*w*	Width of matrix
in	*d*	Height of matrix

template<class dataType> virtual **os::matrix**< dataType >::~**matrix** ( ) [inline], [virtual]

Virtual destructor.

Destructor must be virtual, if an object of this type is deleted, the destructor of the type which inherits this class should be called.

12.11.3 Member Function Documentation

template<class dataType> const dataType& **os::matrix**< dataType >::constGet (uint32_t w, uint32_t h) const

Return constant matrix element.

Uses a width and height position to index an element of the array. This function returns a constant reference, meaning changes cannot be made to the matrix.

Parameters

in	*w*	X position
in	*h*	Y position

Returns

Constant reference to matrix element

template<class dataType> dataType& **os::matrix**< dataType >::get (uint32_t w, uint32_t h)

Return matrix element.

Uses a width and height position to index an element of the array. This function returns a reference, allowing for changes to be made to the matrix.

Parameters

in	*w*	X position
in	*h*	Y position

Returns

Modifiable reference to matrix element

template<class dataType> **smart_ptr**<dataType> **os::matrix**< dataType >::getArray ( ) `[inline]`

Return pointer to the array.

The array which is returned allows for modification of the array. It is up to functions using this array to ensure the integrity of the matrix.

Returns

os::matrix<**dataType**>**::data** (p. 144)

template<class dataType> const **smart_ptr**<dataType> **os::matrix**< dataType >::getConstArray ( ) const `[inline]`

Return a constant pointer to the array.

The array which is returned allows for access to the array. The provided array may not be modified.

Returns

os::matrix<**dataType**>**::data** (p. 144)

template<class dataType> uint32_t **os::matrix**< dataType >::getHeight ( ) const `[inline]`

Return height of matrix.

Returns

matrix<**dataType**>**::height** (p. 145)

template<class dataType> uint32_t **os::matrix**< dataType >::getWidth ( ) const `[inline]`

Return width of matrix.

Returns

matrix<**dataType**>**::width** (p. 145)

template<class dataType> dataType& **os::matrix**< dataType >::operator() (uint32_t w, uint32_t h) `[inline]`

Return matrix element.

Uses a width and height position to index an element of the array. This function returns a reference, allowing for changes to be made to the matrix.

Parameters

`in`	*w*	X position
`in`	*h*	Y position

Returns

Modifiable reference to matrix element

template<class dataType> **matrix**<dataType>& **os::matrix**< dataType >::operator= (const **matrix**< dataType > & m)

Equality constructor.

Re-constructs the raw matrix from another raw matrix. Note that the two matrices do not share the same data array.

Parameters

in	*m*	Reference to matrix being copied

Returns

Reference to self

template<class dataType> **matrix**<dataType>& **os::matrix**< dataType >::operator= (const **indirectMatrix**< dataType > & m)

Equality constructor.

Re-constructs the raw matrix from an indirect matrix. Note that the two matrices do not share the same data array.

Parameters

in	*m*	Reference to matrix being copied

Returns

Reference to self

12.11.4 Friends And Related Function Documentation

template<class dataType> friend class **indirectMatrix**< dataType > [friend]

Indirect matrix interacting with raw matrix.

The os::indirectMatrix<dataType> class must be able to access the size and data of the raw matrix because and indirect matrix can be constructed from a raw matrix.

12.11.5 Member Data Documentation

template<class dataType> **smart_ptr**<dataType> **os::matrix**< dataType >::data [private]

Data array.

For the raw matrix class, this array contains all of the data used by the matrix in a block of size width∗height.

template<class dataType> uint32_t **os::matrix**< dataType >::height `[private]`

Height of the matrix.

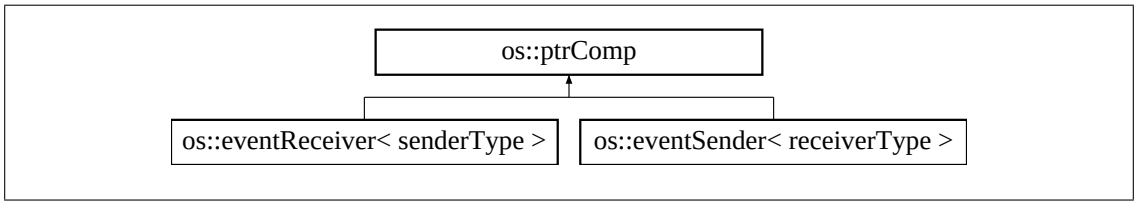
template<class dataType> uint32_t **os::matrix**< dataType >::width `[private]`

Width of the matrix.

12.12 os::ptrComp Class Reference

Pointer compare interface.

Inheritance diagram for os::ptrComp:



Public Member Functions

- virtual ~**ptrComp** ()

  Virtual destructor.
- virtual bool **operator==** (const **ptrComp** &I) const

  Equality test.
- virtual bool **operator**> (const **ptrComp** &I) const

  Greater than test.
- virtual bool **operator**< (const **ptrComp** &I) const

  Less than test.
- virtual bool **operator**>**=** (const **ptrComp** &I) const

  Greater than/equal to test.
- virtual bool **operator**<**=** (const **ptrComp** &I) const

  Less than/equal to test.

12.12.1 Detailed Description

Pointer compare interface.

Allows a class which does not define comparison operators to be placed into an abstract datastructure by defining comparison to be address comparison.

12.12.2 Constructor & Destructor Documentation

virtual os::ptrComp::~ptrComp ( ) [inline], [virtual]

Virtual destructor.

Destructor must be virtual, if an object of this type is deleted, the destructor of the type which inherits this class should be called.

12.12.3 Member Function Documentation

virtual bool os::ptrComp::operator< (const **ptrComp** & l) const [inline], [virtual]

Less than test.

virtual bool os::ptrComp::operator<= (const **ptrComp** & l) const [inline], [virtual]

Less than/equal to test.

virtual bool os::ptrComp::operator== (const **ptrComp** & l) const [inline], [virtual]

Equality test.

virtual bool os::ptrComp::operator> (const **ptrComp** & l) const [inline], [virtual]

Greater than test.

virtual bool os::ptrComp::operator>= (const **ptrComp** & l) const [inline], [virtual]

Greater than/equal to test.

12.13 os::smart_ptr< dataType > Class Template Reference

Reference counted pointer.

Public Member Functions

- **smart_ptr** ()

  Default constructor.
- **smart_ptr** (const **smart_pointer_type** t, const std::atomic< unsigned long > *rc, const dataType *rp, const **void_rec** f)

  Forced constructor.
- **smart_ptr** (const **smart_ptr**< dataType > &sp)

  Copy constructor.
- **smart_ptr** (const dataType *rp, **smart_pointer_type** typ=**raw_type**)

  Standard constructor.
- **smart_ptr** (const dataType *rp, const **void_rec** destructor)

  Dynamic deletion constructor.
- virtual ~**smart_ptr** ()

Virtual destructor.

- **smart_ptr** (const int rp)

  Integer constructor.
- **smart_ptr** (const long rp)

  Long constructor.
- **smart_ptr** (const unsigned long rp)

  Unsigned long constructor.
- **smart_pointer_type getType** () const

  Return type.
- dataType * **get** ()

  Return data.
- const dataType * **get** () const

  Return constant data.
- const dataType * **constGet** () const

  Return constant data.
- const std::atomic< unsigned long > * **getRefCount** () const

  Return constant reference count.
- **void_rec getFunc** () const

  Return deletion function.
- bool **operator!** () const

  Inverted boolean conversion.
- **operator bool** () const

  Boolean conversion.
- dataType & **operator*** ()

  De-reference conversion.
- const dataType & **operator*** () const

  Constant de-reference conversion.
- dataType * **operator->** ()

  Pointer pass.
- const dataType * **operator->** () const

  Constant pointer pass.
- dataType & **operator[ ]** (unsigned int i)

  Array de-reference.
- const dataType & **operator[ ]** (unsigned int i) const

  Constant array de-reference.
- **smart_ptr**< dataType > & **bind** (**smart_ptr**< dataType > sp)

  Bind copy.
- **smart_ptr**< dataType > & **bind** (const dataType *rp)

  Bind raw copy.
- **smart_ptr**< dataType > & **operator=** (const **smart_ptr**< dataType > source)

  Equals copy.
- **smart_ptr**< dataType > & **operator=** (const dataType *source)

  Bind raw copy.

- **smart_ptr**< dataType > & **operator=** (const int source)

  Bind integer copy.
- **smart_ptr**< dataType > & **operator=** (const long source)

  Bind long copy.
- **smart_ptr**< dataType > & **operator=** (const unsigned long source)

  Bind unsigned long copy.
- int **compare** (const **smart_ptr**< dataType > &c) const

  *Compare **os::smart_ptr*** (p. *146*).
- int **compare** (const dataType ∗c) const

  Compare raw pointers.
- int **compare** (const unsigned long c) const

  Compare cast long.

Private Member Functions

- void **teardown** ()

  Delete data.

Private Attributes

- **smart_pointer_type type**

  Stores the type.
- std::atomic< unsigned long > ∗ **ref_count**

  Reference count.
- dataType ∗ **raw_ptr**

  Pointer to data.
- **void_rec func**

  Non-standard deletion.

12.13.1 Detailed Description

template<class dataType>
class os::smart_ptr< dataType >

Reference counted pointer.

The **os::smart_ptr** (p. 146) template class allows for automatic memory management. **os::smart_ptr** (p. 146)'s have a type defined by **os::smart_pointer_type** (p. 84) which defines the copy and deletion behaviour of the object.

12.13.2 Constructor & Destructor Documentation

template<class dataType> **os::smart_ptr**< dataType >::**smart_ptr** ( ) `[inline]`

Default constructor.

Constructs an **os::smart_ptr** (p. 146) of type **os::null_type** (p. 84). All private data is set to 0 or NULL.

template<class dataType> **os::smart_ptr**< dataType >::**smart_ptr** (const **smart_pointer_type** t, const std::atomic< unsigned long > * rc, const dataType * rp, const **void_rec** f) [inline]

Forced constructor.

Constructs an **os::smart_ptr** (p. 146) explicitly from each of the parameters provided. This constructor is primarily used for testing purposes.

Parameters

in	*t*	Type definition for the object
in,out	*rp*	Pointer to the reference count
in	*rp*	Raw pointer object is managing
in	*f*	Dynamic deletion function

template<class dataType> **os::smart_ptr**< dataType >::**smart_ptr** (const **smart_ptr**< dataType > & sp) [inline]

Copy constructor.

Constructs an **os::smart_ptr** (p. 146) from an existing **os::smart_ptr** (p. 146). Will increment the reference count as defined by the received **os::smart_pointer_type** (p. 84).

Parameters

in,out	*sp*	Reference to data being copied

template<class dataType> **os::smart_ptr**< dataType >::**smart_ptr** (const dataType * rp, **smart_pointer_type** typ = **raw_type**) [inline]

Standard constructor.

Constructs an **os::smart_ptr** (p. 146) from a raw pointer and a type. This is the most commonly used **os::smart_ptr** (p. 146) constructor, other than the copy constructor. Note that **os::shared_type_dynamic_delete** (p. 84) cannot be constructed through this method.

Parameters

in	*rp*	Raw pointer object is managing
in	*typ*	Defines reference count behaviour

template<class dataType> **os::smart_ptr**< dataType >::**smart_ptr** (const dataType * rp, const **void_rec** destructor) [inline]

Dynamic deletion constructor.

Constructs an **os::smart_ptr** (p. 146) from a raw pointer and a destruction function. This constructor generates an **os::smart_ptr** (p. 146) of type **os::shared_type_dynamic_delete** (p. 84).

Parameters

in	*rp*	Raw pointer object is managing
in	*destructor*	Defines the function to be executed on destroy

template<class dataType> virtual **os::smart_ptr**< dataType >::~**smart_ptr** ( ) [inline], [virtual]

Virtual destructor.

Calls **os::smart_ptr**<**dataType**>**::teardown()** (p. 156) before destroying the object.

template<class dataType> **os::smart_ptr**< dataType >::**smart_ptr** (const int rp) [inline]

Integer constructor.

Constructs an **os::smart_ptr** (p. 146) from an integer. The assumption is that this integer is 0 (or NULL). This function is still legal if the integer is not NULL, this allows for casting, although such usage is discouraged.

Parameters

in	*rp*	Integer cast to raw pointer

template<class dataType> **os::smart_ptr**< dataType >::**smart_ptr** (const long rp) [inline]

Long constructor.

Constructs an **os::smart_ptr** (p. 146) from an long. The assumption is that this long is 0 (or NULL). This function is still legal if the long is not NULL, this allows for casting, although such usage is discouraged.

Parameters

in	*rp*	Long cast to raw pointer

template<class dataType> **os::smart_ptr**< dataType >::**smart_ptr** (const unsigned long rp) [inline]

Unsigned long constructor.

Constructs an **os::smart_ptr** (p. 146) from an unsigned long. The assumption is that this unsigned long is 0 (or NULL). This function is still legal if the unsigned long is not NULL, this allows for casting, although such usage is discouraged.

Parameters

in	*rp*	Unsigned long cast to raw pointer

12.13.3 Member Function Documentation

template<class dataType> **smart_ptr**<dataType>& **os::smart_ptr**< dataType >::bind (**smart_ptr**< dataType > sp) `[inline]`

Bind copy.

Binds to an **os::smart_ptr** (p. 146) from an existing **os::smart_ptr** (p. 146). Will increment the reference count as defined by the received **os::smart_pointer_type** (p. 84).

Parameters

`in`	*sp*	Reference to data being copied

Returns

Reference to self

template<class dataType> **smart_ptr**<dataType>& **os::smart_ptr**< dataType >::bind (const dataType * rp) `[inline]`

Bind raw copy.

Binds to an **os::smart_ptr** (p. 146) from a dataType pointer. This new **os::smart_ptr** (p. 146) will be of type **os::raw_type** (p. 84) unless the dataType pointer is NULL, then it will be of type **os::null_type** (p. 84).

Parameters

`in`	*rp*	Reference to dataType pointer

Returns

Reference to self

template<class dataType> int **os::smart_ptr**< dataType >::compare (const **smart_ptr**< dataType > & c) const `[inline]`

Compare **os::smart_ptr** (p. 146).

Compares two pointers to the same type by address and returns the result in the form of a 1,0 or -1. Note that the **os::smart_ptr**<**dataType**>**::type** (p. 157) of the objects does not factor into this comparison.

Parameters

`in`	*c*	os::smart_ptr<dataType>

Returns

1, 0, -1 (Greater than, equal to, less than)

template<class dataType> int **os::smart_ptr**< dataType >::compare (const dataType * c) const [inline]

Compare raw pointers.

Compares a os::smart_ptr<dataType> and a raw pointer of type dataType and returns the result in the form of a 1,0 or -1.

Parameters

in	*c*	Raw dataType pointer

Returns

1, 0, -1 (Greater than, equal to, less than)

template<class dataType> int **os::smart_ptr**< dataType >::compare (const unsigned long c) const [inline]

Compare cast long.

Compares a os::smart_ptr<dataType> and an unsigned long, returning the result in the form of a 1,0 or -1.

Parameters

in	*c*	Unsigned long cast to dataType pointer

Returns

1, 0, -1 (Greater than, equal to, less than)

template<class dataType> const dataType* **os::smart_ptr**< dataType >::constGet ( ) const [inline]

Return constant data.

Returns the constant dataType pointer of the **os::smart_ptr** (p. 146).

Returns

dataType* in constant form, **os::smart_ptr**<**dataType**>**::raw_ptr** (p. 156)

template<class dataType> dataType* **os::smart_ptr**< dataType >::get ( ) [inline]

Return data.

Returns the dataType pointer of the **os::smart_ptr** (p. 146).

Returns

dataType* in modifiable form, **os::smart_ptr**<**dataType**>**::raw_ptr** (p. 156)

template<class dataType> const dataType* **os::smart_ptr**< dataType >::get ( ) const [inline]

Return constant data.

Returns the constant dataType pointer of the **os::smart_ptr** (p. 146).

Returns

dataType* in constant form, **os::smart_ptr**<**dataType**>**::raw_ptr** (p. 156)

template<class dataType> **void_rec os::smart_ptr**< dataType >::getFunc ( ) const [inline]

Return deletion function.

Returns the deletion function if it exists. (Note that the deletion function only exists in **os::shared_type_dynamic_delete** (p. 84) mode)

Returns

os::void_rec (p. 83) **os::smart_ptr**<**dataType**>**::func** (p. 156)

template<class dataType> const std::atomic<unsigned long>* **os::smart_ptr**< dataType >::getRefCount ( ) const [inline]

Return constant reference count.

Returns a constant pointer of the reference count.

Returns

unsigned long* in constant form, **os::smart_ptr**<**dataType**>**::ref_count** (p. 157)

template<class dataType> **smart_pointer_type os::smart_ptr**< dataType >::getType ( ) const [inline]

Return type.

Returns the **os::smart_pointer_type** (p. 84) of the **os::smart_ptr** (p. 146).

Returns

os::smart_pointer_type (p. 84) **os::smart_ptr**<**dataType**>**::type** (p. 157)

template<class dataType> **os::smart_ptr**< dataType >::operator bool ( ) const [inline]

Boolean conversion.

Returns

os::smart_ptr<**dataType**>**::raw_ptr** (p. 156) cast to boolean

template<class dataType> bool **os::smart_ptr**< dataType >::operator! ( ) const [inline]

Inverted boolean conversion.

Returns

Inverse of **os::smart_ptr**<**dataType**>**::raw_ptr** (p. 156) cast to boolean

template<class dataType> dataType& **os::smart_ptr**< dataType >::operator∗ ( ) `[inline]`

De-reference conversion.

Returns

dataType reference of **os::smart_ptr**<**dataType**>**::raw_ptr** (p. 156) de-referenced

template<class dataType> const dataType& **os::smart_ptr**< dataType >::operator∗ ( ) const `[inline]`

Constant de-reference conversion.

Returns

Constant dataType reference of **os::smart_ptr**<**dataType**>**::raw_ptr** (p. 156) de-referenced

template<class dataType> dataType∗ **os::smart_ptr**< dataType >::operator-> ( ) `[inline]`

Pointer pass.

Returns

os::smart_ptr<**dataType**>**::raw_ptr** (p. 156)

template<class dataType> const dataType∗ **os::smart_ptr**< dataType >::operator-> ( ) const `[inline]`

Constant pointer pass.

Returns

Constant **os::smart_ptr**<**dataType**>**::raw_ptr** (p. 156)

template<class dataType> **smart_ptr**<dataType>& **os::smart_ptr**< dataType >::operator= (const **smart_ptr**< dataType > source) `[inline]`

Equals copy.
Calls **os::smart_ptr**<**dataType**>**::bind** (p. 151).

Parameters

`in`	*source*	Reference to data being copied

Returns

Reference to self

template<class dataType> **smart_ptr**<dataType>& **os::smart_ptr**< dataType >::operator= (const dataType ∗ source) `[inline]`

Bind raw copy.
Calls **os::smart_ptr**<**dataType**>**::bind** (p. 151).

Parameters

in	*source*	Reference to dataType pointer

Returns

Reference to self

template<class dataType> **smart_ptr**<dataType>& **os::smart_ptr**< dataType >::operator= (const int source) [inline]

Bind integer copy.

Calls **os::smart_ptr**<**dataType**>**::bind** (p. 151) with the integer cast to a dataType pointer.

Parameters

in	*source*	Integer cast to raw pointer

Returns

Reference to self

template<class dataType> **smart_ptr**<dataType>& **os::smart_ptr**< dataType >::operator= (const long source) [inline]

Bind long copy.

Calls **os::smart_ptr**<**dataType**>**::bind** (p. 151) with the long cast to a dataType pointer.

Parameters

in	*source*	Long cast to raw pointer

Returns

Reference to self

template<class dataType> **smart_ptr**<dataType>& **os::smart_ptr**< dataType >::operator= (const unsigned long source) [inline]

Bind unsigned long copy.

Calls **os::smart_ptr**<**dataType**>**::bind** (p. 151) with the unsigned long cast to a dataType pointer.

Parameters

in	*source*	Unsigned long cast to raw pointer

Returns

Reference to self

template<class dataType> dataType& **os::smart_ptr**< dataType >::operator[] (unsigned int i) `[inline]`

Array de-reference.

Returns

dataType reference of **os::smart_ptr**<**dataType**>**::raw_ptr** (p. 156) incremented i de-referenced

template<class dataType> const dataType& **os::smart_ptr**< dataType >::operator[] (unsigned int i) const `[inline]`

Constant array de-reference.

Returns

Constant dataType reference of **os::smart_ptr**<**dataType**>**::raw_ptr** (p. 156) incremented i de-referenced

template<class dataType> void **os::smart_ptr**< dataType >::teardown ( ) `[inline]`, `[private]`

Delete data.

Tears down the **os::smart_ptr** (p. 146). Decrements the reference counter, if not of **os::raw_type** (p. 84) or **os::null_type** (p. 84), and delete **os::smart_ptr**<**dataType**>**::raw_ptr** (p. 156) if needed. Note that if **os::smart_ptr**<**dataType**>**::raw_ptr** (p. 156) is deleted, so is **os::smart_ptr**<**data**↩**Type**>**::ref_count** (p. 157).

Returns

void

12.13.4 Member Data Documentation

template<class dataType> **void_rec os::smart_ptr**< dataType >::func `[private]`

Non-standard deletion.

This is a pointer to a function used when the **os::smart_ptr** (p. 146) is of type **os::shared_type**↩**_dynamic_delete** (p. 84).

template<class dataType> dataType* **os::smart_ptr**< dataType >::raw_ptr `[private]`

Pointer to data.

The **os::smart_ptr**<**dataType**>**::raw_ptr** (p. 156) holds the pointer to the block of memory to be managed by the **os::smart_ptr** (p. 146). If this pointer is NULL, the **os::smart_ptr** (p. 146) is of type **os::null_type** (p. 84).

template<class dataType> std::atomic<unsigned long>* **os::smart_ptr**< dataType >::ref_count `[private]`

Reference count.

This pointer stores the current reference count of the **os::smart_ptr** (p. 146). Note that all **os::smart_ptr** (p. 146)'s which point to the same memory address with share the same reference counter. This counter is deleted with the pointer and if this counter is NULL, the **os::smart_ptr** (p. 146) is either of type **os::null_type** (p. 84) or **os::raw_type** (p. 84).

template<class dataType> **smart_pointer_type os::smart_ptr**< dataType >::type `[private]`

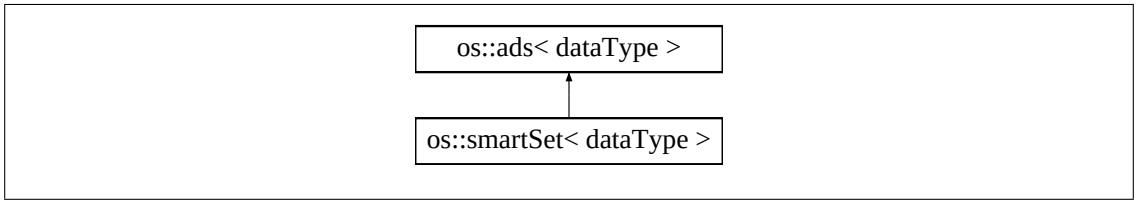
Stores the type.

Defines the type of the **os::smart_ptr** (p. 146). See **os::smart_pointer_type** (p. 84) for details on the available types.

12.14 os::smartSet< dataType > Class Template Reference

Smart set abstract data-structures.

Inheritance diagram for os::smartSet< dataType >:



Public Member Functions

- **smartSet** (**setTypes** typ=**def_set**)

  Default constructor.
- virtual ~**smartSet** ()

  Virtual destructor.
- void **rebuild** (**setTypes** typ)

  Set set type.
- **setTypes getType** () const

  Return set type.
- bool **insert** (**smart_ptr**< **ads**< dataType > > x)

  Inserts an os::ads<dataType>
- bool **insert** (**smart_ptr**< dataType > x)

  Inserts a data node.
- **smart_ptr**< **adnode**< dataType > > **find** (**smart_ptr**< dataType > x)

  Finds a matching node.
- bool **findDelete** (**smart_ptr**< dataType > x)

  Finds and delete a matching node.

- unsigned int **size** () const

  Returns the number of elements in the set.
- **smart_ptr**< **adnode**< dataType > > **getFirst** ()

  Return the first element.
- **smart_ptr**< **adnode**< dataType > > **getLast** ()

  Return the last element.

Private Member Functions

- void **build** (**setTypes** typ)

Private Attributes

- **setTypes type**

  Stores the set type.
- **smart_ptr**< **ads**< dataType > > **current_struct**

  Abstract data-structure storing data.

Additional Inherited Members

12.14.1 Detailed Description

template<class dataType>
class os::smartSet< dataType >

Smart set abstract data-structures.

Wraps other forms of abstract data structures, allowing applications to define abstract data-structures by numbered indexes.

12.14.2 Constructor & Destructor Documentation

template<class dataType > **os::smartSet**< dataType >::**smartSet** (**setTypes** typ = **def_set**) `[inline]`

Default constructor.

This constructor builds the smart set based on a set type. Will call **os::smartSet**<**dataType**>↩ **::build** (p. 159).

Parameters

`in`	*typ*	Set type, default is **os::def_set** (p. 83)

template<class dataType > virtual **os::smartSet**< dataType >::~**smartSet** ( ) `[inline]`, `[virtual]`

Virtual destructor.

Destructor must be virtual, if an object of this type is deleted, the destructor of the type which inherits this class should be called.

12.14.3 Member Function Documentation

template<class dataType > void **os::smartSet**< dataType >::build (**setTypes** typ) [inline], [private]

template<class dataType > **smart_ptr**<**adnode**<dataType> > **os::smartSet**< dataType >::find (**smart_ptr**< dataType > x) [inline], [virtual]

Finds a matching node.

Finds a pointer to an object of type "dataType" given a comparison pointer. Adopts the find function of the abstract data-structure used for this set type. If no abstract data-structure exists, return false.

[in] x dataType pointer to be compared against

Returns

true if the node was found, else false

Reimplemented from **os::ads**< **dataType** > (p. 94).

template<class dataType > bool **os::smartSet**< dataType >::findDelete (**smart_ptr**< dataType > x) [inline], [virtual]

Finds and delete a matching node.

Finds a pointer to an object of type "dataType" given a comparison pointer and remove it. Adopts the findDelete function of the abstract data-structure used for this set type. If no abstract data-structure exists, return false.

[in] x dataType pointer to be compared against

Returns

true if the node was found, else false

Reimplemented from **os::ads**< **dataType** > (p. 95).

template<class dataType > **smart_ptr**<**adnode**<dataType> > **os::smartSet**< dataType >::getFirst ( ) [inline], [virtual]

Return the first element.

Adopts the getFirst function of the abstract data-structure used for this set type. If no abstract data-structure exists, return NULL.

Returns

os::smartSet<**dataType**>**::current_struct** (p. 161)->**getFirst()** (p. 159)

Reimplemented from **os::ads**< **dataType** > (p. 95).

template<class dataType > **smart_ptr**<**adnode**<dataType> > **os::smartSet**< dataType >::getLast ( ) [inline], [virtual]

Return the last element.

Adopts the getLast function of the abstract data-structure used for this set type. If no abstract data-structure exists, return NULL.

Returns

os::smartSet<**dataType**>**::current_struct** (p. 161)->**getLast()** (p. 160)

Reimplemented from **os::ads**< **dataType** > (p. 95).

template<class dataType > **setTypes os::smartSet**< dataType >::getType ( ) const [inline]

Return set type.

Returns

os::smartSet<**dataType**>**::type** (p. 161)

template<class dataType > bool **os::smartSet**< dataType >::insert (**smart_ptr**< **ads**< dataType > > x) [inline], [virtual]

Inserts an os::ads<dataType>

Inserts every element in a given abstract datastructure into this tree. Adopts the insertion function of os::ads<dataType>

[in] x pointer to os::ads<dataType>

Returns

true if successful, false if failed

Reimplemented from **os::ads**< **dataType** > (p. 96).

template<class dataType > bool **os::smartSet**< dataType >::insert (**smart_ptr**< dataType > x) [inline], [virtual]

Inserts a data node.

Adopts the insertion function of the abstract data-structure used for this set type. If no abstract data-structure exists, return false.

[in] x dataType pointer to be inserted

Returns

true if successful, false if failed

Reimplemented from **os::ads**< **dataType** > (p. 95).

template<class dataType > void **os::smartSet**< dataType >::rebuild (**setTypes** typ) [inline]

Set set type.

Sets the type of the set, rebuilding the set if the requested type and current type do not match.

Parameters

`in`	*type*	Set type

Returns

void

template<class dataType > unsigned int **os::smartSet**< dataType >::size ( ) const `[inline]`, `[virtual]`

Returns the number of elements in the set.

Adopts the size function of the abstract data-structure used for this set type. If no abstract data-structure exists, return 0.

Returns

os::smartSet<**dataType**>**::current_struct** (p. 161)->**size()** (p. 161)

Reimplemented from **os::ads**< **dataType** > (p. 97).

12.14.4 Member Data Documentation

template<class dataType > **smart_ptr**<**ads**<dataType> > **os::smartSet**< dataType >::current_struct `[private]`

Abstract data-structure storing data.

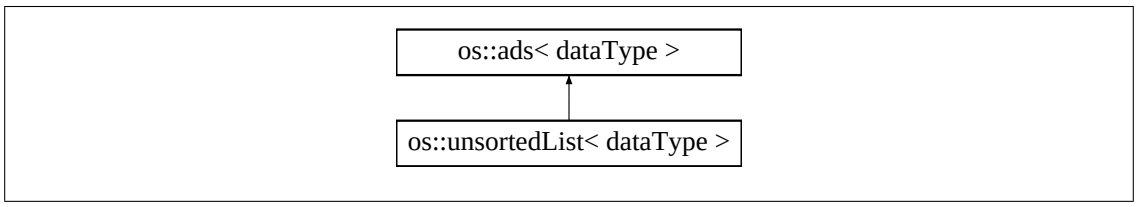
template<class dataType > **setTypes os::smartSet**< dataType >::type `[private]`

Stores the set type.

12.15 os::unsortedList< dataType > Class Template Reference

Unsorted linked list.

Inheritance diagram for os::unsortedList< dataType >:



Public Member Functions

- **unsortedList** ()
  Default constructor.
- virtual ~**unsortedList** ()
  Virtual destructor.
- bool **insert** (**smart_ptr**< **ads**< dataType > > x)
  Inserts an os::ads<dataType>
- bool **insert** (**smart_ptr**< dataType > x)
  Inserts a data node.
- virtual unsigned int **size** () const
  Returns the number of elements in the list.
- **smart_ptr**< **adnode**< dataType > > **find** (**smart_ptr**< dataType > x)
  Finds a matching node.
- bool **findDelete** (**smart_ptr**< dataType > x)
  Finds and delete a matching node.
- **smart_ptr**< **adnode**< dataType > > **getFirst** ()
  Return the head.
- **smart_ptr**< **adnode**< dataType > > **getLast** ()
  Return the tail.

Private Attributes

- **smart_ptr**< **unsortedListNode**< dataType > > **head**
  Head node.
- **smart_ptr**< **unsortedListNode**< dataType > > **tail**
  Tail node.
- unsigned int **_size**
  Number of elements in the list.

Additional Inherited Members

12.15.1 Detailed Description

template<class dataType>
class os::unsortedList< dataType >

Unsorted linked list.

The list defined by this class is searchable but unsorted. Insert checks to see if the element being inserted is already contained inside the list. Elements are inserted from the front of the list.

12.15.2 Constructor & Destructor Documentation

template<class dataType > **os::unsortedList**< dataType >::**unsortedList** ( ) `[inline]`

Default constructor.

Sets the number of elements to 0 and the head and tail to NULL.

template<class dataType > virtual **os::unsortedList**< dataType >::~**unsortedList** ( ) [inline], [virtual]

Virtual destructor.

Destructor must be virtual, if an object of this type is deleted, the destructor of the type which inherits this class should be called. The list must explicitly force deletion through setting all of the next and previous references of nodes to NULL.

12.15.3 Member Function Documentation

template<class dataType > **smart_ptr**<**adnode**<dataType> > **os::unsortedList**< dataType >::find (**smart_ptr**< dataType > x) [inline], [virtual]

Finds a matching node.

Finds a pointer to an object of type "dataType" given a comparison pointer. This comparison function is defined by os::adnode<dataType>::compare(smart_ptr<adnode<dataType> >). This function takes O(n) where n is the number of elements in the list.

[in] x dataType pointer to be compared against

Returns

true if the node was found, else false

Reimplemented from **os::ads**< **dataType** > (p. 94).

template<class dataType > bool **os::unsortedList**< dataType >::findDelete (**smart_ptr**< dataType > x) [inline], [virtual]

Finds and delete a matching node.

Finds a pointer to an object of type "dataType" given a comparison pointer and removes it. This comparison function is defined by os::adnode<dataType>::compare(smart_ptr<adnode<dataType> >). This function takes O(n) where n is the number of elements in the list.

[in] x dataType pointer to be compared against

Returns

true if the node was found, else false

Reimplemented from **os::ads**< **dataType** > (p. 95).

template<class dataType > **smart_ptr**<**adnode**<dataType> > **os::unsortedList**< dataType >::getFirst ( ) [inline], [virtual]

Return the head.

This function is O(1)

Returns

os::unsortedList<**dataType**>**::head** (p. 165)

Reimplemented from **os::ads**< **dataType** > (p. 95).

template<class dataType > **smart_ptr**<**adnode**<dataType> > **os::unsortedList**< dataType >::getLast ( ) [inline], [virtual]

Return the tail.
This function is O(1).

Returns

os::unsortedList<**dataType**>**::tail** (p. 165)

Reimplemented from **os::ads**< **dataType** > (p. 95).

template<class dataType > bool **os::unsortedList**< dataType >::insert (**smart_ptr**< **ads**< dataType > > x) [inline], [virtual]

Inserts an os::ads<dataType>
Inserts every element in a given abstract datastructure into this tree. Adopts the insertion function of os::ads<dataType>
[in] x pointer to os::ads<dataType>

Returns

true if successful, false if failed

Reimplemented from **os::ads**< **dataType** > (p. 96).

template<class dataType > bool **os::unsortedList**< dataType >::insert (**smart_ptr**< dataType > x) [inline], [virtual]

Inserts a data node.
Inserts a pointer to an object of type "dataType." This insertion will place the node into the list at the beginning. If the node already exists, it will not be inserted. This means that this function must first attempt to find the node being inserted. This function is O(n).
[in] x dataType pointer to be inserted

Returns

true if successful, false if failed

Reimplemented from **os::ads**< **dataType** > (p. 95).

template<class dataType > virtual unsigned int **os::unsortedList**< dataType >::size ( ) const [inline], [virtual]

Returns the number of elements in the list.

Returns

os::unsortedList<dataType>::numElements

Reimplemented from **os::ads**< **dataType** > (p. 97).

12.15.4 Member Data Documentation

template<class dataType > unsigned int **os::unsortedList**< dataType >::_size [private]

Number of elements in the list.

template<class dataType > **smart_ptr**<**unsortedListNode**<dataType> > **os::unsortedList**< dataType >::head [private]

Head node.

Contains a pointer to the head node in the list. If this node is NULL, the list is empty.

template<class dataType > **smart_ptr**<**unsortedListNode**<dataType> > **os::unsortedList**< dataType >::tail [private]

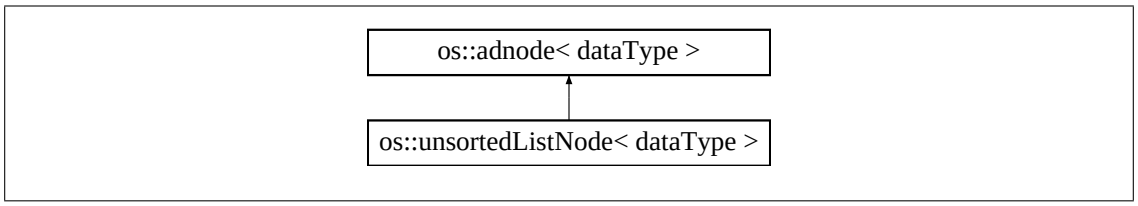
Tail node.

Contains a pointer to the tail node in the list. If this node is NULL, the list is empty.

12.16 os::unsortedListNode< dataType > Class Template Reference

Node for usage in a linked list.

Inheritance diagram for os::unsortedListNode< dataType >:



Public Member Functions

- **unsortedListNode** (**smart_ptr**< dataType > d)

  Abstract data-node constructor.
- virtual ~**unsortedListNode** ()

  Virtual destructor.
- **smart_ptr**< **adnode**< dataType > > **getNext** ()

  Return the next node.
- **smart_ptr**< **adnode**< dataType > > **getPrev** ()

  Return the previous node.

Protected Member Functions

- void **remove** ()

  Remove this node from the list.

Protected Attributes

- **smart_ptr**< **unsortedListNode**< dataType > > **prev**

  Previous node.
- **smart_ptr**< **unsortedListNode**< dataType > > **next**

  Next node.

Friends

- class **unsortedList**< **dataType** >

  List aware of it's nodes.

12.16.1 Detailed Description

template<class dataType>
class os::unsortedListNode< dataType >

Node for usage in a linked list.

This class is a simple extension of the os::adnode<dataType> class. It holds the previous and next node inside of it as well as a pointer to its data. Note that the os::unsortedLIst<dataType> class implements the mechanics of the list.

12.16.2 Constructor & Destructor Documentation

template<class dataType > **os::unsortedListNode**< dataType >::**unsortedListNode** (**smart_ptr**< dataType > d) `[inline]`

Abstract data-node constructor.

A list node is meaningless without a pointer to it's dataType. The constructor requires this pointer to initialize the node. Next and previous nodes are, by default, initialized to zero.

Parameters

`in`	*d*	Data to be bound to the node

template<class dataType > virtual **os::unsortedListNode**< dataType >::~**unsortedListNode** ( ) `[inline]`, `[virtual]`

Virtual destructor.

Destructor must be virtual, if an object of this type is deleted, the destructor of the type which inherits this class should be called.

12.16.3 Member Function Documentation

template<class dataType > **smart_ptr**<**adnode**<dataType> > **os::unsortedListNode**< dataType >::getNext ( ) `[inline]`, `[virtual]`

Return the next node.

Note that **os::unsortedListNode**<**dataType**>**::next** (p. 167) is of type os::unsortedListNode<data↩ Type>, but this function returns type of os::adnode<dataType>. **os::unsortedListNode**<**data↩ Type**>**::next** (p. 167) must be case before returning.

Returns

os::unsortedListNode<**dataType**>**::next** (p. 167)

Reimplemented from **os::adnode**< **dataType** > (p. 92).

template<class dataType > **smart_ptr**<**adnode**<dataType> > **os::unsortedListNode**< dataType >::getPrev ( ) [inline], [virtual]

Return the previous node.

Note that **os::unsortedListNode**<**dataType**>**::prev** (p. 168) is of type os::unsortedListNode<data↩ Type>, but this function returns type of os::adnode<dataType>. **os::unsortedListNode**<**data↩ Type**>**::prev** (p. 168) must be case before returning.

Returns

os::unsortedListNode<**dataType**>**::prev** (p. 168)

Reimplemented from **os::adnode**< **dataType** > (p. 92).

template<class dataType > void **os::unsortedListNode**< dataType >::remove ( ) [inline], [protected]

Remove this node from the list.

Removes the references to this node from the next and previous node, if they exists. Sets the previous and next nodes to NULL.

Returns

void

12.16.4 Friends And Related Function Documentation

template<class dataType > friend class **unsortedList**< dataType > [friend]

List aware of it's nodes.

The unsorted list must be aware of the inner-workings of its nodes. Only the unsorted list is permitted to access the private members of this class.

12.16.5 Member Data Documentation

template<class dataType > **smart_ptr**<**unsortedListNode**<dataType> > **os::unsortedListNode**< dataType >::next [protected]

Next node.

Contains a pointer to the next node in the list. If this node is the tail of the list, the next node is NULL.

template<class dataType > **smart_ptr**<**unsortedListNode**<dataType> > **os::unsortedListNode**< dataType >::prev [protected]

Previous node.

Contains a pointer to the previous node in the list. If this node is the head of the list, the previous node is NULL.

12.17 os::vector2d< dataType > Class Template Reference

2-dimensional vector

Public Member Functions

- **vector2d** ()

  Default constructor.
- **vector2d** (dataType xv, dataType yv)

  Value constructor.
- **vector2d** (const **vector2d**< dataType > &vec)

  Copy constructor.
- **vector2d**< dataType > & **operator=** (const **vector2d**< dataType > &vec)

  Equality constructor.
- **vector2d**< dataType > & **operator()** (const dataType &X, const dataType &Y)

  Value setter.
- virtual ~**vector2d** ()

  Virtual destructor s∗ Destructor must be virtual, if an object of this type is deleted, the destructor of the type which inherits this class should be called.
- dataType **length** () const

  Return length of the vector.
- **vector2d**< dataType > & **scaleSelf** (dataType target=1)

  Scales this vector.
- **vector2d**< dataType > **scale** (dataType target=1) const

  Return a scaled vector.
- int **compare** (const **vector2d**< dataType > &vec) const
- bool **operator==** (const **vector2d**< dataType > &vec) const

  Equality comparison operator.
- bool **operator!=** (const **vector2d**< dataType > &vec) const

  Not-equals comparison operator.
- bool **operator**< (const **vector2d**< dataType > &vec) const

  Less-than comparison operator.
- bool **operator**<**=** (const **vector2d**< dataType > &vec) const

  Less-than or equals to comparison operator.
- bool **operator**> (const **vector2d**< dataType > &vec) const

  Less-than comparison operator.
- bool **operator**>**=** (const **vector2d**< dataType > &vec) const

- **vector2d**< dataType > & **addSelf** (const **vector2d**< dataType > &vec)

  Add vector to self.
- **vector2d**< dataType > **add** (const **vector2d**< dataType > &vec) const

  Add two vectors.
- **vector2d**< dataType > **operator+** (const **vector2d**< dataType > &vec) const

  Add two vectors.
- **vector2d**< dataType > & **operator+=** (const **vector2d**< dataType > &vec)

  Add vector to self.
- **vector2d**< dataType > & **operator++** ()

  Increment.
- **vector2d**< dataType > **operator++** (int dummy)

  Increment.
- **vector2d**< dataType > **operator-** () const

  Invert vector.
- **vector2d**< dataType > & **subtractSelf** (const **vector2d**< dataType > &vec)

  Subtract vector from self.
- **vector2d**< dataType > **subtract** (const **vector2d**< dataType > &vec) const

  Subtract two vectors.
- **vector2d**< dataType > **operator-** (const **vector2d**< dataType > &vec) const

  Subtracts two vectors.
- **vector2d**< dataType > & **operator-=** (const **vector2d**< dataType > &vec)

  Subtracts vector from self.
- **vector2d**< dataType > & **operator--** ()

  Decrement.
- **vector2d**< dataType > **operator--** (int dummy)

  Decrement.
- dataType **dotProduct** (const **vector2d**< dataType > &vec) const

  Dot-product.
- **vector2d**< dataType > **rotate** (const **vector2d**< dataType > &vec) const

  Rotates a point around 0, 0.
- **vector2d**< dataType > **rotateSelf** (const **vector2d**< dataType > &vec)

  Rotates self around 0, 0.

Public Attributes

- dataType **x**

  X axis vector component.
- dataType **y**

  Y axis vector component.

12.17.1 Detailed Description

template<class dataType>
class os::vector2d< dataType >

2-dimensional vector

This template class contains the functions and operators needed to preform arithmetic on a 2 dimensional vector

12.17.2 Constructor & Destructor Documentation

template<class dataType> **os::vector2d**< dataType >::**vector2d** ( ) `[inline]`

Default constructor.

Constructs a 2 dimensional vector with x and y as 0.

template<class dataType> **os::vector2d**< dataType >::**vector2d** (dataType xv, dataType yv) `[inline]`

Value constructor.

Constructs a 2 dimensional vector with a x and a y value.

Parameters

`in`	*xv*	Value of x dimension
`in`	*yv*	Value of y dimension

template<class dataType> **os::vector2d**< dataType >::**vector2d** (const **vector2d**< dataType > & vec) `[inline]`

Copy constructor.

Constructs a 2 dimensional vector from a 2 dimensional vector

Parameters

`in`	*vec*	Vector to be copied

template<class dataType> virtual **os::vector2d**< dataType >::~**vector2d** ( ) `[inline]`, `[virtual]`

Virtual destructor s∗ Destructor must be virtual, if an object of this type is deleted, the destructor of the type which inherits this class should be called.

12.17.3 Member Function Documentation

template<class dataType> **vector2d**<dataType> **os::vector2d**< dataType >::add (const **vector2d**< dataType > & vec) const [inline]

Add two vectors.

Adds the provided vector to the current vector and returns a new vector. This function is essentially the function version of the '+' operator.

Parameters

in	*vec*	Reference to vector to be added

Returns

Result of the vector addition

template<class dataType> **vector2d**<dataType>& **os::vector2d**< dataType >::addSelf (const **vector2d**< dataType > & vec) [inline]

Add vector to self.

Adds the provided vector to the current vector. THis function is essentially the function version of the '+=' operator.

Parameters

in	*vec*	Reference to vector to be added

Returns

Reference to self

template<class dataType> int **os::vector2d**< dataType >::compare (const **vector2d**< dataType > & vec) const [inline]

Compares two vectors

This function compares two vectors for equality. It does not change either vector. This function returns 1 if this object is greater that the object reference received, 0 if the two are equal and -1 if the received reference is greater than the object.

Parameters

in	*vec*	Reference to object compared against

Returns

1 if greater than, 0 if equal to, -1 if less than

template<class dataType> dataType **os::vector2d**< dataType >::dotProduct (const **vector2d**< dataType > & vec) const [inline]

Dot-product.

Calculates the scalar dot-product. Note that this function does not return a vector, but rather, returns a scalar.

Parameters

in	*vec*	Reference to vector

Returns

Scalar dot product

template<class dataType> dataType **os::vector2d**< dataType >::length ( ) const [inline]

Return length of the vector.

Returns sqrt(x^2+y^2), or the length of the vector.

Returns

Length of the vector

template<class dataType> bool **os::vector2d**< dataType >::operator!= (const **vector2d**< dataType > & vec) const [inline]

Not-equals comparison operator.

Parameters

in	*vec*	Reference to object compared against

Returns

true if vectors are not equal

template<class dataType> **vector2d**<dataType>& **os::vector2d**< dataType >::operator() (const dataType & X, const dataType & Y) [inline]

Value setter.

Sets the values of a 2 dimensional vector with a x and a y value.

Parameters

in	*X*	Value of x dimension
in	*Y*	Value of y dimension

Returns

Reference to this vector

template<class dataType> **vector2d**<dataType> **os::vector2d**< dataType >::operator+ (const **vector2d**< dataType > & vec) const [inline]

Add two vectors.

Parameters

in	*vec*	Reference to vector to be added

Returns

vector2d<dataType>::add(vec)

template<class dataType> **vector2d**<dataType>& **os::vector2d**< dataType >::operator++ ( ) [inline]

Increment.

Increments this vector by the unit vector of the same direction and then returns a reference to this vector.

Returns

Reference to self

template<class dataType> **vector2d**<dataType> **os::vector2d**< dataType >::operator++ (int dummy) [inline]

Increment.

Copies this vector then increments this vector by the unit vector of the same direction and then returns the original copy.

Parameters

in	*dummy*	Parameter required to define operator

Returns

Original copy

template<class dataType> **vector2d**<dataType>& **os::vector2d**< dataType >::operator+= (const **vector2d**< dataType > & vec) [inline]

Add vector to self.

Parameters

in	*vec*	Reference to vector to be added

Returns

vector3d<dataType>::addSelf(vec)

template<class dataType> **vector2d**<dataType> **os::vector2d**< dataType >::operator- ( ) const `[inline]`

Invert vector.

Constructs a new vector with an inverted x and inverted y.

Returns

Inverted vector

template<class dataType> **vector2d**<dataType> **os::vector2d**< dataType >::operator- (const **vector2d**< dataType > & vec) const `[inline]`

Subtracts two vectors.

Parameters

`in`	*vec*	Reference to vector to be subtracted

Returns

vector2d<dataType>::subtract(vec)

template<class dataType> **vector2d**<dataType>& **os::vector2d**< dataType >::operator-- ( ) `[inline]`

Decrement.

Decrements this vector by the unit vector of the same direction and then returns a reference to this vector.

Returns

Reference to self

template<class dataType> **vector2d**<dataType> **os::vector2d**< dataType >::operator-- (int dummy) `[inline]`

Decrement.

Copies this vector then decrements this vector by the unit vector of the same direction and then returns the original copy.

Parameters

`in`	*dummy*	Parameter required to define operator

Returns

Original copy

template<class dataType> **vector2d**<dataType>& **os::vector2d**< dataType >::operator-= (const **vector2d**< dataType > & vec) [inline]

Subtracts vector from self.

Parameters

in	*vec*	Reference to vector to be subtracted

Returns

vector3d<dataType>::subtractSelf(vec)

template<class dataType> bool **os::vector2d**< dataType >::operator< (const **vector2d**< dataType > & vec) const [inline]

Less-than comparison operator.

Parameters

in	*vec*	Reference to object compared against

Returns

true if this is less than vec

template<class dataType> bool **os::vector2d**< dataType >::operator<= (const **vector2d**< dataType > & vec) const [inline]

Less-than or equals to comparison operator.

Parameters

in	*vec*	Reference to object compared against

Returns

true if this is less than vec

template<class dataType> **vector2d**<dataType>& **os::vector2d**< dataType >::operator= (const **vector2d**< dataType > & vec) [inline]

Equality constructor.
Set the values of a 2 dimensional vector from a another 2 dimensional vector

Parameters

in	*vec*	Vector to be copied

Returns

Reference to this vector

template<class dataType> bool **os::vector2d**< dataType >::operator== (const **vector2d**< dataType > & vec) const [inline]

Equality comparison operator.

Parameters

in	*vec*	Reference to object compared against

Returns

true if vectors are equal

template<class dataType> bool **os::vector2d**< dataType >::operator> (const **vector2d**< dataType > & vec) const [inline]

Less-than comparison operator.

Parameters

in	*vec*	Reference to object compared against

Returns

true if this is less than vec

template<class dataType> bool **os::vector2d**< dataType >::operator>= (const **vector2d**< dataType > & vec) const [inline]

template<class dataType> **vector2d**<dataType> **os::vector2d**< dataType >::rotate (const **vector2d**< dataType > & vec) const [inline]

Rotates a point around 0, 0.

Parameters

in	*vec*	Vector representing an angle

Returns

Rotated point

template<class dataType> **vector2d**<dataType> **os::vector2d**< dataType >::rotateSelf (const **vector2d**< dataType > & vec) [inline]

Rotates self around 0, 0.

Parameters

in	*vec*	Vector representing an angle

Returns

Rotated point

template<class dataType> **vector2d**<dataType> **os::vector2d**< dataType >::scale (dataType target = 1) const [inline]

Return a scaled vector.

Returns a vector scaled to the given target length. This operation, by default, will scale to a distance of 1 (the unit vector)

Parameters

in	*target*	Vector length to be scaled to

Returns

The scaled vector

template<class dataType> **vector2d**<dataType>& **os::vector2d**< dataType >::scaleSelf (dataType target = 1) [inline]

Scales this vector.

Scales this vector to the given target length. This operation, by default, will scale to a distance of 1 (the unit vector)

Parameters

in	*target*	Vector length to be scaled to

Returns

Reference to this

template<class dataType> **vector2d**<dataType> **os::vector2d**< dataType >::subtract (const **vector2d**< dataType > & vec) const [inline]

Subtract two vectors.

Subtracts the provided vector from the current vector and returns a new vector. This function is essentially the function version of the '-' operator.

Parameters

in	*vec*	Reference to vector to be subtracted

Returns

Result of the vector subtraction

template<class dataType> **vector2d**<dataType>& **os::vector2d**< dataType >::subtractSelf (const **vector2d**< dataType > & vec) [inline]

Subtract vector from self.

Subtracts the provided vector from the current vector. THis function is essentially the function version of the '-=' operator.

Parameters

in	*vec*	Reference to vector to be subtracted

Returns

Reference to self

12.17.4 Member Data Documentation

template<class dataType> dataType **os::vector2d**< dataType >::x

X axis vector component.

template<class dataType> dataType **os::vector2d**< dataType >::y

Y axis vector component.

12.18 os::vector3d< dataType > Class Template Reference

3-dimensional vector

Public Member Functions

- **vector3d** ()

  Default constructor.
- **vector3d** (dataType xv, dataType yv, dataType zv=0)

  Value constructor.
- **vector3d** (const **vector3d**< dataType > &vec)

  Copy constructor.
- **vector3d** (const **vector2d**< dataType > &vec)

  Copy constructor.
- **vector3d**< dataType > & **operator=** (const **vector3d**< dataType > &vec)

  Equality constructor.
- **vector3d**< dataType > & **operator()** (const dataType &X, const dataType &Y, const dataType &Z)

  Value setter.
- virtual ~**vector3d** ()

  Virtual destructor s∗ Destructor must be virtual, if an object of this type is deleted, the destructor of the type which inherits this class should be called.
- dataType **length** () const

  Return length of the vector.
- **vector3d**< dataType > & **scaleSelf** (dataType target=1)

  Scales this vector.
- **vector3d**< dataType > **scale** (dataType target=1) const

  Return a scaled vector.
- int **compare** (const **vector3d** &vec) const
- bool **operator==** (const **vector3d**< dataType > &vec) const

  Equality comparison operator.
- bool **operator!=** (const **vector3d**< dataType > &vec) const

  Not-equals comparison operator.
- bool **operator**< (const **vector3d**< dataType > &vec) const

  Less-than comparison operator.
- bool **operator**<**=** (const **vector3d**< dataType > &vec) const

  Less-than or equal to comparison operator.
- bool **operator**> (const **vector3d**< dataType > &vec) const

  Greater-than comparison operator.
- bool **operator**>**=** (const **vector3d**< dataType > &vec) const

  Greater-than or equal to comparison operator.
- **vector3d**< dataType > & **addSelf** (const **vector3d**< dataType > &vec)

  Add vector to self.
- **vector3d**< dataType > **add** (const **vector3d**< dataType > &vec) const

  Add two vectors.
- **vector3d**< dataType > **operator+** (const **vector3d**< dataType > &vec) const

  Add two vectors.
- **vector3d**< dataType > & **operator+=** (const **vector3d**< dataType > &vec)

Add vector to self.

- **vector3d**< dataType > & **operator++** ()

  Increment.
- **vector3d**< dataType > **operator++** (int dummy)

  Increment.
- **vector3d**< dataType > **operator-** () const

  Invert vector.
- **vector3d**< dataType > & **subtractSelf** (const **vector3d**< dataType > &vec)

  Subtract vector from self.
- **vector3d**< dataType > **subtract** (const **vector3d**< dataType > &vec) const

  Subtract two vectors.
- **vector3d**< dataType > **operator-** (const **vector3d**< dataType > &vec) const

  Subtracts two vectors.
- **vector3d**< dataType > & **operator-=** (const **vector3d**< dataType > &vec)

  Subtracts vector from self.
- **vector3d**< dataType > & **operator--** ()

  Decrement.
- **vector3d**< dataType > **operator--** (int dummy)

  Decrement.
- dataType **dotProduct** (const **vector3d**< dataType > &vec) const

  Dot-product.
- **vector3d**< dataType > **crossProduct** (const **vector3d**< dataType > &vec) const

  Cross-product.
- **vector3d**< dataType > & **crossSelf** (const **vector3d**< dataType > &vec)

  Cross-product to self.
- **vector3d**< dataType > **operator**∗ (const **vector3d**< dataType > &vec) const

  Cross-product.
- **vector3d**< dataType > & **operator**∗**=** (const **vector3d**< dataType > &vec)

  Self cross-product.

Public Attributes

- dataType **x**

  X axis vector component.
- dataType **y**

  Y axis vector component.
- dataType **z**

  Z axis vector component.

12.18.1 Detailed Description

template<class dataType>
class os::vector3d< dataType >

3-dimensional vector

This template class contains the functions and operators needed to preform arithmetic on a 3 dimensional vector

12.18.2 Constructor & Destructor Documentation

template<class dataType> **os::vector3d**< dataType >::**vector3d** ( ) `[inline]`

Default constructor.

Constructs a 3 dimensional vector with x, y and z as 0.

template<class dataType> **os::vector3d**< dataType >::**vector3d** (dataType xv, dataType yv, dataType zv = `0`) `[inline]`

Value constructor.

Constructs a 3 dimensional vector with x, y and z values. Z, by default, is initialized as 0.

Parameters

`in`	*xv*	Value of x dimension
`in`	*yv*	Value of y dimension
`in`	*zv*	Value of z dimension

template<class dataType> **os::vector3d**< dataType >::**vector3d** (const **vector3d**< dataType > & vec) `[inline]`

Copy constructor.

Constructs a 3 dimensional vector from another 3 dimensional vector

Parameters

`in`	*vec*	Vector to be copied

Returns

Reference to this vector

template<class dataType> **os::vector3d**< dataType >::**vector3d** (const **vector2d**< dataType > & vec) `[inline]`

Copy constructor.

Constructs a 3 dimensional vector from a 2 dimensional vector

Parameters

in	*vec*	Vector to be copied

Returns

Reference to this vector

template<class dataType> virtual **os::vector3d**< dataType >::~**vector3d** ( ) [inline], [virtual]

Virtual destructor s∗ Destructor must be virtual, if an object of this type is deleted, the destructor of the type which inherits this class should be called.

12.18.3 Member Function Documentation

template<class dataType> **vector3d**<dataType> **os::vector3d**< dataType >::add (const **vector3d**< dataType > & vec) const [inline]

Add two vectors.

Adds the provided vector to the current vector and returns a new vector. This function is essentially the function version of the '+' operator.

Parameters

in	*vec*	Reference to vector to be added

Returns

Result of the vector addition

template<class dataType> **vector3d**<dataType>& **os::vector3d**< dataType >::addSelf (const **vector3d**< dataType > & vec) [inline]

Add vector to self.

Adds the provided vector to the current vector. THis function is essentially the function version of the '+=' operator.

Parameters

in	*vec*	Reference to vector to be added

Returns

Reference to self

template<class dataType> int **os::vector3d**< dataType >::compare (const **vector3d**< dataType > & vec) const [inline]

Compares two vectors

This function compares two vectors for equality. It does not change either vector. This function returns 1 if this object is greater that the object reference received, 0 if the two are equal and -1 if the received reference is greater than the object.

Parameters

in	*vec*	Reference to object compared against

Returns

1 if greater than, 0 if equal to, -1 if less than

template<class dataType> **vector3d**<dataType> **os::vector3d**< dataType >::crossProduct (const **vector3d**< dataType > & vec) const [inline]

Cross-product.

Preform the cross-product computation on this vector and the vector argument provided. Unlike the dot-product, the cross product returns a vector.

Parameters

in	*vec*	Reference to vector to be computed

Returns

Result of the cross-product

template<class dataType> **vector3d**<dataType>& **os::vector3d**< dataType >::crossSelf (const **vector3d**< dataType > & vec) [inline]

Cross-product to self.

Preform the cross-product computation on this vector and the vector argument provided. Binds the result to this and returns a reference to this vector.

Parameters

in	*vec*	Reference to vector to be computed

Returns

Reference to self

template<class dataType> dataType **os::vector3d**< dataType >::dotProduct (const **vector3d**< dataType > & vec) const `[inline]`

Dot-product.

Calculates the scalar dot-product. Note that this function does not return a vector, but rather, returns a scalar.

Parameters

`in`	*vec*	Reference to vector

Returns

Scalar dot product

template<class dataType> dataType **os::vector3d**< dataType >::length ( ) const `[inline]`

Return length of the vector.

Returns sqrt(x^2+y^2+z^2), or the length of the vector.

Returns

Length of the vector

template<class dataType> bool **os::vector3d**< dataType >::operator!= (const **vector3d**< dataType > & vec) const `[inline]`

Not-equals comparison operator.

Parameters

`in`	*vec*	Reference to object compared against

Returns

true if vectors are not equal

template<class dataType> **vector3d**<dataType>& **os::vector3d**< dataType >::operator() (const dataType & X, const dataType & Y, const dataType & Z) `[inline]`

Value setter.

Sets values of a 3 dimensional vector with x, y and z values.

Parameters

`in`	*X*	Value of x dimension

Parameters

in	*Y*	Value of y dimension
in	*Z*	Value of z dimension

Returns

Reference to this vector

template<class dataType> **vector3d**<dataType> **os::vector3d**< dataType >::operator∗ (const **vector3d**< dataType > & vec) const [inline]

Cross-product.

Parameters

in	*vec*	Reference to vector to be computed with

Returns

vector3d<dataType>::crossProduct(vec)

template<class dataType> **vector3d**<dataType>& **os::vector3d**< dataType >::operator∗= (const **vector3d**< dataType > & vec) [inline]

Self cross-product.

Parameters

in	*vec*	Reference to vector to be computed with

Returns

vector3d<dataType>::crossSelf(vec)

template<class dataType> **vector3d**<dataType> **os::vector3d**< dataType >::operator+ (const **vector3d**< dataType > & vec) const [inline]

Add two vectors.

Parameters

in	*vec*	Reference to vector to be added

Returns

vector3d<dataType>::add(vec)

template<class dataType> **vector3d**<dataType>& **os::vector3d**< dataType >::operator++ ( ) [inline]

Increment.

Increments this vector by the unit vector of the same direction and then returns a reference to this vector.

Returns

Reference to self

template<class dataType> **vector3d**<dataType> **os::vector3d**< dataType >::operator++ (int dummy) [inline]

Increment.

Copies this vector then increments this vector by the unit vector of the same direction and then returns the original copy.

Parameters

in	*dummy*	Parameter required to define operator

Returns

Original copy

template<class dataType> **vector3d**<dataType>& **os::vector3d**< dataType >::operator+= (const **vector3d**< dataType > & vec) [inline]

Add vector to self.

Parameters

in	*vec*	Reference to vector to be added

Returns

vector3d<dataType>::addSelf(vec)

template<class dataType> **vector3d**<dataType> **os::vector3d**< dataType >::operator- ( ) const [inline]

Invert vector.

Constructs a new vector with an inverted x, inverted y and inverted z.

Returns

Inverted vector

template<class dataType> **vector3d**<dataType> **os::vector3d**< dataType >::operator- (const **vector3d**< dataType > & vec) const [inline]

Subtracts two vectors.

Parameters

in	*vec*	Reference to vector to be subtracted

Returns

vector3d<dataType>::subtract(vec)

template<class dataType> **vector3d**<dataType>& **os::vector3d**< dataType >::operator-- ( ) [inline]

Decrement.

Decrements this vector by the unit vector of the same direction and then returns a reference to this vector.

Returns

Reference to self

template<class dataType> **vector3d**<dataType> **os::vector3d**< dataType >::operator-- (int dummy) [inline]

Decrement.

Copies this vector then decrements this vector by the unit vector of the same direction and then returns the original copy.

Parameters

in	*dummy*	Parameter required to define operator

Returns

Original copy

template<class dataType> **vector3d**<dataType>& **os::vector3d**< dataType >::operator-= (const **vector3d**< dataType > & vec) [inline]

Subtracts vector from self.

Parameters

in	*vec*	Reference to vector to be subtracted

Returns

vector3d<dataType>::subtractSelf(vec)

template<class dataType> bool **os::vector3d**< dataType >::operator< (const **vector3d**< dataType > & vec) const [inline]

Less-than comparison operator.

Parameters

in	*vec*	Reference to object compared against

Returns

true if this is less than vec

template<class dataType> bool **os::vector3d**< dataType >::operator<= (const **vector3d**< dataType > & vec) const [inline]

Less-than or equal to comparison operator.

Parameters

in	*vec*	Reference to object compared against

Returns

true if this is less than or equal to vec

template<class dataType> **vector3d**<dataType>& **os::vector3d**< dataType >::operator= (const **vector3d**< dataType > & vec) [inline]

Equality constructor.
Set the values of a 3 dimensional vector from a another 3 dimensional vector

Parameters

in	*vec*	Vector to be copied

Returns

Reference to this vector

template<class dataType> bool **os::vector3d**< dataType >::operator== (const **vector3d**< dataType > & vec) const [inline]

Equality comparison operator.

Parameters

in	*vec*	Reference to object compared against

Returns

true if vectors are equal

template<class dataType> bool **os::vector3d**< dataType >::operator> (const **vector3d**< dataType > & vec) const [inline]

Greater-than comparison operator.

Parameters

in	*vec*	Reference to object compared against

Returns

true if this is greater than vec

template<class dataType> bool **os::vector3d**< dataType >::operator>= (const **vector3d**< dataType > & vec) const [inline]

Greater-than or equal to comparison operator.

Parameters

in	*vec*	Reference to object compared against

Returns

true if this is greater than or equal to vec

template<class dataType> **vector3d**<dataType> **os::vector3d**< dataType >::scale (dataType target = 1) const [inline]

Return a scaled vector.

Returns a vector scaled to the given target length. This operation, by default, will scale to a distance of 1 (the unit vector)

Parameters

in	*target*	Vector length to be scaled to

Returns

The scaled vector

template<class dataType> **vector3d**<dataType>& **os::vector3d**< dataType >::scaleSelf (dataType target = 1) [inline]

Scales this vector.

Scales this vector to the given target length. This operation, by default, will scale to a distance of 1 (the unit vector)

Parameters

in	*target*	Vector length to be scaled to

Returns

Reference to this

template<class dataType> **vector3d**<dataType> **os::vector3d**< dataType >::subtract (const **vector3d**< dataType > & vec) const [inline]

Subtract two vectors.

Subtracts the provided vector to the current vector and returns a new vector. This function is essentially the function version of the '-' operator.

Parameters

in	*vec*	Reference to vector to be subtracted

Returns

Result of the vector subtraction

template<class dataType> **vector3d**<dataType>& **os::vector3d**< dataType >::subtractSelf (const **vector3d**< dataType > & vec) [inline]

Subtract vector from self.

Subtracts the provided vector from the current vector. THis function is essentially the function version of the '-=' operator.

Parameters

in	*vec*	Reference to vector to be subtracted

Returns

Reference to self

12.18.4 Member Data Documentation

template<class dataType> dataType **os::vector3d**< dataType >::x

X axis vector component.

template<class dataType> dataType **os::vector3d**< dataType >::y

Y axis vector component.

template<class dataType> dataType **os::vector3d**< dataType >::z

Z axis vector component.