rational

1.7

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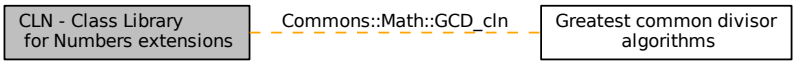
Module Documentation

3.1 CLN - Class Library for Numbers extensions

Collaboration diagram for CLN - Class Library for Numbers extensions:



Classes

- struct Commons::Math::GCD_cln< T, IsSigned, CHKOP, CONV >

  CLN GCD algorithm.

Macros

- #define CLN_PRECISION "30"
- #define CLN_EPSILON "1L-16_" CLN_PRECISION

Typedefs

- typedef Rational< cln::cl_I, Commons::Math::GCD_cln, Commons::Math::NO_OPERATOR_CHECK > Commons::Math::cln_rational

  Rational class based on the CLN library.

3.1.1 Detailed Description

The header `cln_rational.h` contains specializations especially for the `CLN - Class Library for Numbers` as underlying storage type.

If you use the *CLN extensions*, you'll need to link your application with `-lcln`

3.1.2 Macro Definition Documentation

3.1.2.1 #define CLN_EPSILON "1L-16_" CLN_PRECISION

```
#include <cln_rational.h>
```

The `EPSILON` used for approximating a float

See also

CLN_PRECISION
Commons::Math::EPSILON

This define is passed *as is* to the contructor of `cln::cl_F`

3.1.2.2 #define CLN_PRECISION "30"

```
#include <cln_rational.h>
```

The default precision suffix

See also

CLN_EPSILON
Commons::Math::EPSILON
Commons::Math::TYPE_CONVERT

3.1.3 Typedef Documentation

3.1.3.1 typedef Rational<cln::cl_I, Commons::Math::GCD_cln, Commons::Math::NO_OPERATOR_CHECK> Commons::Math::cln_rational

```
#include <cln_rational.h>
```

Rational class based on the CLN library.

3.2 Expression templates

Classes

- struct Commons::Math::RationalExpressionTraits< ExprT >

  Traits struct for expression templates.

Functions

- template<class T , template< typename, bool, template< class, typename, bool > class, template< typename > class > class GCD, template< class, typename, bool > class CHKOP>
  RationalExpression< T, RationalConstant< T, GCD, CHKOP >, GCD, CHKOP > Commons::Math::mk_rat_lit (const Rational< T, GCD, CHKOP > &r)

  make a literal for use in expressions

- template<class T , class E , template< typename, bool, template< class, typename, bool > class, template< typename > class > class GCD, template< class, typename, bool > class CHKOP>
  RationalExpression< T, RationalVariable< T, GCD, CHKOP >, GCD, CHKOP > Commons::Math::mk_rat_proto_var (const RationalExpression< T, E, GCD, CHKOP > &)

  make a variable from a prototype

- template<class T , template< typename, bool, template< class, typename, bool > class, template< typename > class > class GCD, template< class, typename, bool > class CHKOP>
  RationalExpression< T, RationalVariable< T, GCD, CHKOP >, GCD, CHKOP > Commons::Math::mk_rat_proto_var (const Rational< T, GCD, CHKOP > &)

- template<class ExprT >
  RationalExpressionTraits< ExprT >::expr_type::result_type Commons::Math::eval_rat_expr (const ExprT &expr, const typename RationalExpressionTraits< ExprT >::expr_type::result_type &val=typename RationalExpressionTraits< ExprT >::expr_type::result_type())

  evaluates an expression

- template<class T , class A , template< typename, bool, template< class, typename, bool > class, template< typename > class > class GCD, template< class, typename, bool > class CHKOP>
  Commons::Math::RationalExpression< T, Commons::Math::RationalUnaryExpression< T, Commons::Math::RationalExpression< T, A, GCD, CHKOP >, Commons::Math::_unaryAbs< Commons::Math::Rational< T, GCD, CHKOP > >, GCD, CHKOP >, GCD, CHKOP > abs (const Commons::Math::RationalExpression< T, A, GCD, CHKOP > &a)

  the absolute value of an expression

- template<class T , class A , template< typename, bool, template< class, typename, bool > class, template< typename > class > class GCD, template< class, typename, bool > class CHKOP>
  Commons::Math::RationalExpression< T, Commons::Math::RationalUnaryExpression< T, Commons::Math::RationalConstant< A, GCD, CHKOP >, Commons::Math::_unaryAbs< Commons::Math::Rational< T, GCD, CHKOP > >, GCD, CHKOP >, GCD, CHKOP > abs (const Commons::Math::Rational< A, GCD, CHKOP > &a)

- template<class T , class A , template< typename, bool, template< class, typename, bool > class, template< typename > class > class GCD, template< class, typename, bool > class CHKOP>
  Commons::Math::RationalExpression< T, Commons::Math::RationalUnaryExpression< T, Commons::Math::RationalExpression< T, A, GCD, CHKOP >, Commons::Math::_unaryInv< Commons::Math::Rational< T, GCD, CHKOP > >, GCD, CHKOP >, GCD, CHKOP > inv (const Commons::Math::RationalExpression< T, A, GCD, CHKOP > &a)

  inverts an expression

- template<class T , class A , template< typename, bool, template< class, typename, bool > class, template< typename > class > class GCD, template< class, typename, bool > class CHKOP>
  Commons::Math::RationalExpression< T, Commons::Math::RationalUnaryExpression< T, Commons::Math::RationalConstant< A, GCD, CHKOP >, Commons::Math::_unaryInv< Commons::Math::Rational< T, GCD, CHKOP > >, GCD, CHKOP >, GCD, CHKOP > inv (const Commons::Math::Rational< A, GCD, CHKOP > &a)

3.2.1 Detailed Description

The *expression templates module* allows you to write your code in *domain-specific expressions* (DSE) as well as to lazy evaluate them.

Caveats:

- With *C++03* it is **not** possible to store expressions, but only to use them directly where expressions are expected as parameters.
  With *C++11* you can use the keyword `auto` to store expressions
- Number literals are only possible at the right side of binary operators.
  This literals get converted by using the *approximation* constructor Commons::Math::Rational(const Number↩ Type &number)

Example:
To approximate the integral $\int_a^b \frac{x}{1+x}$ by evaluating the expression $\frac{x}{1+x}$ for a specified number of equidistant points in the interval $[1, 5]$, using the GNU Multiple Precisions extensions, you could write following `integrate()` template function:

```
template<class ExprT> inline static
Commons::Math::gmp_rational integrate ( const ExprT &e,
                                        const Commons::Math::gmp_rational &from,
                                        const Commons::Math::gmp_rational &to,
                                        std::size_t n ) {
    Commons::Math::gmp_rational sum;

    const static Commons::Math::gmp_rational two ( 2, 1 );
    const Commons::Math::gmp_rational &step ( ( to - from ) / n );

    for ( Commons::Math::gmp_rational i ( from + ( step / two ) ); i < to;
          i += step ) {

          sum += Commons::Math::eval_rat_expr ( e, i );
    }

    return step * sum;
}
```

next you can call the `integrate()` function like:

```
// declare the variable x from prototype gmp_rational
const RationalExpressionTraits<gmp_rational>::variable_type
    &x ( mk_rat_proto_var ( gmp_rational() ) );

// approximate the integration for the interval [1, 5] using 10 equidistant points
const gmp_rational &r ( integrate ( x / ( x + 1 ), 1, 5, 10 ) );
```

This will yield the result $\frac{422563503196}{145568097675} \approx 2.9$ in `r`.

Note

You have to place the literal `1` as right operand, since *non-expressions* and *non-Rationals* cannot appear at the left side of an operator due to a restriction of the *C++* overload resolution. In this case it makes no difference due to the *commutative property* of the addition.

See also

Commons::Math::RationalExpressionTraits
Commons::Math::mk_rat_lit()
Commons::Math::mk_rat_proto_var()

3.2.2 Function Documentation

3.2.2.1 template<class T , class A , template< typename, bool, template< class, typename, bool > class, template< typename > class > class GCD, template< class, typename, bool > class CHKOP> Commons::Math::RationalExpression<T, Commons::Math::RationalUnaryExpression<T, Commons::Math::RationalExpression<T, A, GCD, CHKOP>, Commons::Math::_unaryAbs<Commons::Math::Rational<T, GCD, CHKOP> >, GCD, CHKOP>, GCD, CHKOP> abs (const Commons::Math::RationalExpression< T, A, GCD, CHKOP > & *a*) [inline]

```
#include <expr_rational.h>
```

the absolute value of an expression

See also

Commons::Math::Rational::abs()

3.2.2.2 template<class T , class A , template< typename, bool, template< class, typename, bool > class, template< typename > class > class GCD, template< class, typename, bool > class CHKOP> Commons::Math::RationalExpression<T, Commons::Math::RationalUnaryExpression<T, Commons::Math::RationalConstant<A, GCD, CHKOP>, Commons::Math::_unaryAbs<Commons::Math::Rational<T, GCD, CHKOP> >, GCD, CHKOP>, GCD, CHKOP> abs (const Commons::Math::Rational< A, GCD, CHKOP > & *a*) [inline]

```
#include <expr_rational.h>
```

This is an overloaded member function, provided for convenience. It differs from the above function only in what argument(s) it accepts.

3.2.2.3 template<class ExprT > RationalExpressionTraits<ExprT>::expr_type::result_type Commons::Math::eval_rat_expr (const ExprT & *expr*, const typename Commons::Math::RationalExpressionTraits< ExprT >::expr_type::result_type & *val* = typename Commons::Math::RationalExpressionTraits<ExprT>::expr_type::result_type()) [inline]

```
#include <expr_rational.h>
```

evaluates an expression

Template Parameters

ExprT	the expression template type

Parameters

in	*expr*	the expression to evaluate
in	*val*	the value assigned to the variable

Returns

the result of the evaluated expression

3.2.2.4 template<class T , class A , template< typename, bool, template< class, typename, bool > class, template< typename > class > class GCD, template< class, typename, bool > class CHKOP> Commons::Math::RationalExpression<T, Commons::Math::RationalUnaryExpression<T, Commons::Math::RationalExpression<T, A, GCD, CHKOP>, Commons::Math::_unaryInv<Commons::Math::Rational<T, GCD, CHKOP> >, GCD, CHKOP>, GCD, CHKOP> inv (const Commons::Math::RationalExpression< T, A, GCD, CHKOP > & *a*) [inline]

```
#include <expr_rational.h>
```

inverts an expression

See also

Commons::Math::Rational::inverse()

3.2.2.5 template<class T , class A , template< typename, bool, template< class, typename, bool > class, template< typename > class > class GCD, template< class, typename, bool > class CHKOP> Commons::Math::RationalExpression<T, Commons::Math::RationalUnaryExpression<T, Commons::Math::RationalConstant<A, GCD, CHKOP>, Commons::Math::_unaryInv<Commons::Math::Rational<T, GCD, CHKOP> >, GCD, CHKOP>, GCD, CHKOP> inv (const Commons::Math::Rational< A, GCD, CHKOP > & *a*) [inline]

`#include <expr_rational.h>`

This is an overloaded member function, provided for convenience. It differs from the above function only in what argument(s) it accepts.

3.2.2.6 template<class T , template< typename, bool, template< class, typename, bool > class, template< typename > class > class GCD, template< class, typename, bool > class CHKOP> RationalExpression<T, RationalConstant<T, GCD, CHKOP>, GCD, CHKOP> Commons::Math::mk_rat_lit (const Rational< T, GCD, CHKOP > & *r*) [inline]

`#include <expr_rational.h>`

make a literal for use in expressions

Example:
to create a literal `l`:

```
const Commons::Math::RationalExpressionTraits
  <Commons::Math::gmp_rational>::expr_type
    &l ( Commons::Math::mk_rat_lit (
      Commons::Math::gmp_rational ( 1, 1 ) ) );
```

See also

Commons::Math::RationalExpressionTraits

Parameters

r	the Rational to create a literal for

Returns

the literal for use in expressions

3.2.2.7 template<class T , class E , template< typename, bool, template< class, typename, bool > class, template< typename > class > class GCD, template< class, typename, bool > class CHKOP> RationalExpression<T, RationalVariable<T, GCD, CHKOP>, GCD, CHKOP> Commons::Math::mk_rat_proto_var (const RationalExpression< T, E, GCD, CHKOP > &) [inline]

`#include <expr_rational.h>`

make a variable from a prototype

The prototype is needed for the compiler to deduce the right type

Example:
to create a variable `x` using the prototype `l` (a literal created by mk_rat_lit() or by another Rational):

```
const Commons::Math::RationalExpressionTraits
  <Commons::Math::gmp_rational>::variable_type
    &x ( Commons::Math::mk_rat_proto_var ( l ) );
```

See also

Commons::Math::RationalExpressionTraits
Commons::Math::mk_rat_lit()

Returns

a variable from a prototype

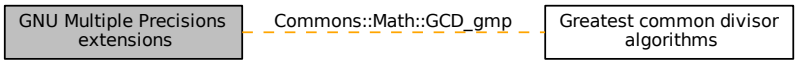
3.2.2.8 template<class T , template< typename, bool, template< class, typename, bool > class, template< typename > class > class GCD, template< class, typename, bool > class CHKOP> RationalExpression<T, RationalVariable<T, GCD, CHKOP>, GCD, CHKOP> Commons::Math::mk_rat_proto_var (const Rational< T, GCD, CHKOP > &) [inline]

```
#include <expr_rational.h>
```

This is an overloaded member function, provided for convenience. It differs from the above function only in what argument(s) it accepts.

3.3 GNU Multiple Precisions extensions

Collaboration diagram for GNU Multiple Precisions extensions:



Classes

- struct Commons::Math::GCD_gmp< T, IsSigned, CHKOP, CONV >
  GMP GCD algorithm.

Macros

- #define GMP_EPSILON "1e-21", 30, 10

Typedefs

- typedef Rational< mpz_class, GCD_gmp, NO_OPERATOR_CHECK > Commons::Math::gmp_rational
  Rational class based on the GMP library.

3.3.1 Detailed Description

The header `gmp_rational.h` contains specializations especially for the GNU Multiple Precision Arithmetic Library as underlying storage type.

If you use the *GMP extensions*, you'll need to link your application with `-lgmpxx -lgmp`

3.3.2 Macro Definition Documentation

3.3.2.1 #define GMP_EPSILON "1e-21", 30, 10

```
#include <gmp_rational.h>
```

The `EPSILON` used for approximating a float

See also

Commons::Math::EPSILON

This define is passed *as is* to the contructor of `mpz_class`

See C++ Interface Integers for details

3.3.3 Typedef Documentation

3.3.3.1 typedef Rational<mpz_class, GCD_gmp, NO_OPERATOR_CHECK> Commons::Math::gmp_rational

```
#include <gmp_rational.h>
```

Rational class based on the GMP library.

3.4 InfInt extensions

Typedefs

- typedef Rational< InfInt, GCD_euclid > Commons::Math::infint_rational

  Rational class based on InfInt.

3.4.1 Detailed Description

The header `infint_rational.h` contains specializations especially for `InfInt` as underlying as underlying storage type.

3.4.2 Typedef Documentation

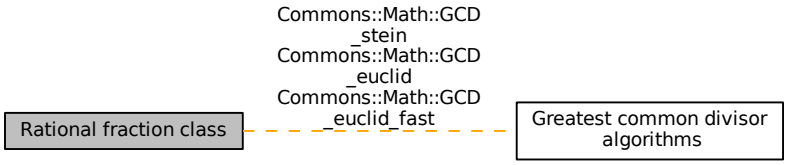
3.4.2.1 typedef Rational<InfInt, GCD_euclid> Commons::Math::infint_rational

```
#include <infint_rational.h>
```

Rational class based on InfInt.

3.5 Rational fraction class

Collaboration diagram for Rational fraction class:



Classes

- struct Commons::Math::TYPE_CONVERT< T >

  Type coversion policy class.
- struct Commons::Math::EPSILON< T >

  EPSILON for float approximation
- struct Commons::Math::NO_OPERATOR_CHECK< Op, T, IsSigned >

  unchecked operator
- struct Commons::Math::ENABLE_OVERFLOW_CHECK< Op, T, IsSigned >

  checked operator
- struct Commons::Math::GCD_stein< T, IsSigned, CHKOP, CONV >

  Stein GCD algorithm implementation.
- struct Commons::Math::GCD_euclid< T, IsSigned, CHKOP, CONV >

  Euclid GCD algorithm (safe) implementation.
- struct Commons::Math::GCD_euclid_fast< T, IsSigned, CHKOP, CONV >

  Euclid GCD algorithm (fast) implementation.
- class Commons::Math::Rational< T, GCD, CHKOP >

  Rational (fraction) template class

Functions

- template<typename T , template< typename, bool, template< class, typename, bool > class, template< typename > class > class GCD, template< class, typename, bool > class CHKOP>
  Commons::Math::Rational< T, GCD, CHKOP > std::modf (const Commons::Math::Rational< T, GCD, CHKOP > &__x, typename Commons::Math::Rational< T, GCD, CHKOP >::integer_type *__iptr)

  Overload of `std::modf` for `Rational` types.

3.5.1 Detailed Description

Include `rational.h` to be able to do fraction calculations. By simply including `rational.h` and specifying the storage type (any integer variant) you can create and use a fractional data type. For example, `Commons::Math::Rational<long> foo(3, 4)` would create a fraction named `foo` with a value of $\frac{3}{4}$, and store the fraction using the `long` data type.

Example:
To approximate the **reciprocal** of the *golden ratio* ($\varphi = \phi^{-1}$)
$\varphi = \frac{\sqrt{5}-1}{2}$
by iteratively calculating the continued fraction
$\varphi = 1 + \cfrac{1}{1+\cfrac{1}{1+\cfrac{1}{1+\cfrac{1}{1+\ddots}}}}$
you could write:

```
Rational<uint64_t> phi ( 1u, 1u );

for ( std::size_t i = 0u; i < 91u; ++i ) ( ++phi ).invert();
```

which will result in $\varphi \approx \frac{754011380474634 6429}{1220016041512187 6738} = 0.6180339887498948482045868343656381 1772$

Note

Use `Commons::Math::Rational::invert()` or just add `1` to get ϕ
As *side effect* you'll get the `i-th` *Fibonacci number* in the numerator of each iteration

3.5.2 Function Documentation

3.5.2.1 template<typename T , template< typename, bool, template< class, typename, bool > class, template< typename > class > class GCD, template< class, typename, bool > class CHKOP> Commons::Math::Rational<T, GCD, CHKOP> std::modf (const Commons::Math::Rational< T, GCD, CHKOP > & *__x*, typename Commons::Math::Rational< T, GCD, CHKOP >::integer_type * *__iptr*) [inline]

```
#include <rational.h>
```

Overload of `std::modf` for `Rational` types.

See also

Rational::mod()

Warning

__iptr **must** point to a valid address and **cannot** be `NULL`

Template Parameters

T	the storage type
GCD	the GCD algorithm
NumberType	the number type
CHKOP	checked operator

See also

ENABLE_OVERFLOW_CHECK

Parameters

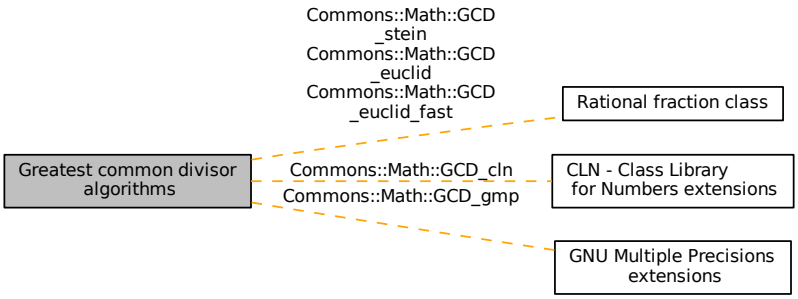
in	*__x*	the `Rational`
out	*__iptr*	address of the `integer_type` to store the integral part

Returns

the Rational part of `__x`

3.6 Greatest common divisor algorithms

Collaboration diagram for Greatest common divisor algorithms:



Classes

- struct Commons::Math::GCD_cln< T, IsSigned, CHKOP, CONV >

  CLN GCD algorithm.
- struct Commons::Math::GCD_gmp< T, IsSigned, CHKOP, CONV >

  GMP GCD algorithm.
- struct Commons::Math::GCD_stein< T, IsSigned, CHKOP, CONV >

  Stein GCD algorithm implementation.
- struct Commons::Math::GCD_euclid< T, IsSigned, CHKOP, CONV >

  Euclid GCD algorithm (safe) implementation.
- struct Commons::Math::GCD_euclid_fast< T, IsSigned, CHKOP, CONV >

  Euclid GCD algorithm (fast) implementation.

3.6.1 Detailed Description

The *greatest common divisor algorithms* are used to reduce a Commons::Math::Rational so that $numerator \perp denominator$, i.e. $gcd(numerator, denominator) = 1$

Example:
A custom GCD algorithm could be implemented as following:

```
template<typename MyType, bool IsSigned, template<class, typename = MyType,
         bool = IsSigned> class CHKOP, template<typename = MyType> class CONV>

struct GCD_myType {

  inline MyType operator() ( const MyType &a, const MyType &b ) const {
      return myType_GCD_impl(a, b);
  }

};
```

and using it at second template parameter:

```
typedef Commons::Math::Rational<MyType, GCD_myType>
      myType_rational;
```

Chapter 4

Class Documentation

4.1 Commons::Math::ENABLE_OVERFLOW_CHECK< Op, T, IsSigned > Struct Template Reference

checked operator

`#include <rational.h>`

4.1.1 Detailed Description

template<class Op, typename T, bool IsSigned>struct Commons::Math::ENABLE_OVERFLOW_CHECK< Op, T, IsSigned >

checked operator

Checks the operands on signed overflows, resp. unsigned wraps and throws a `std::domain_error` if the check fails, else delegates to the operator `Op`

Template Parameters

Op	operator functor
T	storage type
IsSigned	specialization for *signed* or *unsigned* types

4.2 Commons::Math::EPSILON< T > Struct Template Reference

`EPSILON` for float approximation

`#include <rational.h>`

Static Public Member Functions

- static const T value ()

  the value of `EPSILON`

4.2.1 Detailed Description

template<typename T>struct Commons::Math::EPSILON< T >

`EPSILON` for float approximation

Specialize this class if you need another EPSILON (error tolerance)

By default this is

```
std::numeric_limits<T>::epsilon()
```

Template Parameters

T	storage type of Rational

4.2.2 Member Function Documentation

4.2.2.1 template<typename T > static const T Commons::Math::EPSILON< T >::value ( ) [inline], [static]

the value of EPSILON

4.3 Commons::Math::GCD_cln< T, IsSigned, CHKOP, CONV > Struct Template Reference

CLN GCD algorithm.

`#include <cln_rational.h>`

4.3.1 Detailed Description

template<typename T, bool IsSigned, template< class, typename=T, bool=IsSigned > class CHKOP, template< typename=T > class CONV>struct Commons::Math::GCD_cln< T, IsSigned, CHKOP, CONV >

CLN GCD algorithm.

The gcd algorithm implemented in the CLN library

Note

this is currently the **only** supported GCD for use with CLN - Class Library for Numbers extensions

Template Parameters

T	storage type
IsSigned	specialization for *signed* or *unsigned* types
CHKOP	checked operator

See also

ENABLE_OVERFLOW_CHECK

4.4 Commons::Math::GCD_euclid< T, IsSigned, CHKOP, CONV > Struct Template Reference

Euclid GCD algorithm (safe) implementation.

`#include <rational.h>`

4.4.1 Detailed Description

template<typename T, bool IsSigned, template< class, typename=T, bool=IsSigned > class CHKOP, template< typename > class CONV = TYPE_CONVERT>struct Commons::Math::GCD_euclid< T, IsSigned, CHKOP, CONV >

Euclid GCD algorithm (safe) implementation.

This implementation supports overlow/wrap checking

Template Parameters

T	storage type
IsSigned	specialization for *signed* or *unsigned* types
CHKOP	checked operator

See also

ENABLE_OVERFLOW_CHECK

4.5 Commons::Math::GCD_euclid_fast< T, IsSigned, CHKOP, CONV > Struct Template Reference

Euclid GCD algorithm (fast) implementation.

`#include <rational.h>`

4.5.1 Detailed Description

template<typename T, bool IsSigned, template< class, typename=T, bool=IsSigned > class CHKOP, template< typename > class CONV = TYPE_CONVERT>struct Commons::Math::GCD_euclid_fast< T, IsSigned, CHKOP, CONV >

Euclid GCD algorithm (fast) implementation.

See also

GCD_euclid if your number class doesn't support all needed operators

Template Parameters

T	storage type
IsSigned	specialization for *signed* or *unsigned* types
CHKOP	checked operator

See also

ENABLE_OVERFLOW_CHECK

4.6 Commons::Math::GCD_gmp< T, IsSigned, CHKOP, CONV > Struct Template Reference

GMP GCD algorithm.

`#include <gmp_rational.h>`

4.6.1 Detailed Description

template<typename T, bool IsSigned, template< class, typename=T, bool=IsSigned > class CHKOP, template< typename=T > class CONV>struct Commons::Math::GCD_gmp< T, IsSigned, CHKOP, CONV >

GMP GCD algorithm.

The gcd algorithm implemented in the GMP library

Template Parameters

T	storage type
IsSigned	specialization for *signed* or *unsigned* types
CHKOP	checked operator

See also

ENABLE_OVERFLOW_CHECK

4.7 Commons::Math::GCD_stein< T, IsSigned, CHKOP, CONV > Struct Template Reference

Stein GCD algorithm implementation.

`#include <rational.h>`

4.7.1 Detailed Description

template<typename T, bool IsSigned, template< class, typename=T, bool=IsSigned > class CHKOP, template< typename > class CONV = TYPE_CONVERT>struct Commons::Math::GCD_stein< T, IsSigned, CHKOP, CONV >

Stein GCD algorithm implementation.

Template Parameters

T	storage type
IsSigned	specialization for *signed* or *unsigned* types
CHKOP	checked operator

See also

ENABLE_OVERFLOW_CHECK

4.8 Commons::Math::NO_OPERATOR_CHECK< Op, T, IsSigned > Struct Template Reference

unchecked operator

`#include <rational.h>`

4.8.1 Detailed Description

template<class Op, typename T, bool IsSigned>struct Commons::Math::NO_OPERATOR_CHECK< Op, T, IsSigned >

unchecked operator

Delegates the operator Op without any overflow/wrap check

Template Parameters

Op	operator functor
T	storage type
IsSigned	specialization for *signed* or *unsigned* types

4.9 Commons::Math::Rational< T, GCD, CHKOP > Class Template Reference

Rational (fraction) template class

`#include <rational.h>`

Public Types

- typedef T integer_type
  storage type
- typedef _mod< integer_type, GCD, CHKOP, std::numeric_limits< integer_type >::is_signed >::pair_type mod_type
  type of the return value of mod()
- typedef CHKOP< std::plus< T > > op_plus
  addition (a + b) operator
- typedef CHKOP< std::minus< T > > op_minus
  subtraction (a - b) operator
- typedef CHKOP< std::negate< T > > op_negate
  subtraction (a - b) operator
- typedef CHKOP< std::multiplies< T > > op_multiplies
  *multiplication (a * b) operator*
- typedef CHKOP< std::divides< T > > op_divides
  division (a / b) operator
- typedef CHKOP< std::modulus< T > > op_modulus
  modulus (a % b) operator

Public Member Functions

- Rational ()
  creates a default (null) Rational
- Rational (const Rational &other)
  copy constructor
- template<template< typename, bool, template< class, typename, bool > class, template< typename > class > class U1, template< class, typename, bool > class V1, template< typename, bool, template< class, typename, bool > class, template< typename > class > class U2, template< class, typename, bool > class V2>
  Rational (const Rational< integer_type, U1, V1 > &numer, const Rational< integer_type, U2, V2 > &denom)
  creates a Rational
- Rational (const integer_type &numer, const integer_type &denom)
  creates a Rational
- Rational (const integer_type &whole, const integer_type &numer, const integer_type &denom)
  creates a inproper (mixed) Rational
- template<typename NumberType >
  Rational (const NumberType &number)
  creates an approximated Rational
- Rational (const char *expr)

creates a Rational approximated by an expression

- Rational & operator= (const Rational &another)

  assign another Rational

- template<typename NumberType >
  Rational & operator= (const NumberType &number)

  assigns from a `NumberType`

- template<typename NumberType >
  operator NumberType () const

  convert to `NumberType`

- integer_type numerator () const NOEXCEPT

  gets the numerator

- integer_type denominator () const NOEXCEPT

  gets the denominator

- mod_type mod () const

  extract the integral and fractional part

- Rational abs () const

  gets the absolute Rational

- Rational & invert ()

  inverts the Rational

- Rational inverse () const

  gets a copy of the inverted Rational

- Rational & operator+= (const Rational &other)

  add and assign a Rational

- Rational operator+ (const Rational &other) const

  add a Rational

- Rational operator+ () const

  get a copy of the Rational

- Rational & operator++ ()

  pre-increment a Rational

- Rational operator++ (int)

  post-increment a Rational

- Rational & operator-= (const Rational &other)

  subtract and assign a Rational

- Rational operator- (const Rational &other) const

  subtract a Rational

- Rational operator- () const

  get a negated copy of the Rational

- Rational & operator-- ()

  pre-decrement a Rational

- Rational operator-- (int)

  post-decrement a Rational

- Rational & operator*= (const Rational &other)

  multiply and assign a Rational

- Rational operator* (const Rational &other) const

  multiply a Rational

- Rational & operator/= (const Rational &other)

  divide and assign a Rational

- Rational operator/ (const Rational &other) const

  divide a Rational

- Rational & operator%= (const Rational &other)

  modulo and assign a Rational

- Rational operator% (const Rational &other) const
  modulo a Rational
- bool operator== (const Rational &other) const
  test on equality
- bool operator!= (const Rational &other) const
  test on inequality
- bool operator< (const Rational &other) const
  test if less than
- bool operator<= (const Rational &other) const
  test if less or equal than
- bool operator> (const Rational &other) const
  test if greater than
- bool operator>= (const Rational &other) const
  test if greater or equal than
- bool operator! () const
  test if it is the neutral element to addition and subtraction
- std::string str (bool mixed=false) const
  generates the string representation of Rational

Static Public Attributes

- static const integer_type zero_ = integer_type()
  represents zero in the given Rational::integer_type
- static const integer_type one_ = integer_type (1)
  represents one in the given Rational::integer_type

Friends

- std::ostream & operator<< (std::ostream &o, const Rational &r)
  output stream operator
- std::istream & operator>> (std::istream &i, Rational &r)
  reads in an `expression` from a `std::istream` and assign it to `r`

Related Functions

(Note that these are not member functions.)

- template<typename NumberType , typename T , template< typename, bool, template< class, typename, bool > class, template< typename > class > class GCD, template< class, typename, bool > class CHKOP>
  NumberType & operator+= (NumberType &n, const Rational< T, GCD, CHKOP > &o)
- template<typename T , template< typename, bool, template< class, typename, bool > class, template< typename > class > class GCD, template< class, typename, bool > class CHKOP, typename NumberType >
  Rational< T, GCD, CHKOP > operator+ (const Rational< T, GCD, CHKOP > &o, const NumberType &n)
- template<typename NumberType , typename T , template< typename, bool, template< class, typename, bool > class, template< typename > class > class GCD, template< class, typename, bool > class CHKOP>
  Rational< T, GCD, CHKOP > operator+ (const NumberType &n, const Rational< T, GCD, CHKOP > &o)
- template<typename NumberType , typename T , template< typename, bool, template< class, typename, bool > class, template< typename > class > class GCD, template< class, typename, bool > class CHKOP>
  NumberType & operator-= (NumberType &n, const Rational< T, GCD, CHKOP > &o)
- template<typename T , template< typename, bool, template< class, typename, bool > class, template< typename > class > class GCD, template< class, typename, bool > class CHKOP, typename NumberType >
  Rational< T, GCD, CHKOP > operator- (const Rational< T, GCD, CHKOP > &o, const NumberType &n)

- template<typename NumberType , typename T , template< typename, bool, template< class, typename, bool > class, template< typename > class > class GCD, template< class, typename, bool > class CHKOP>
  Rational< T, GCD, CHKOP > operator- (const NumberType &n, const Rational< T, GCD, CHKOP > &o)
- template<typename NumberType , typename T , template< typename, bool, template< class, typename, bool > class, template< typename > class > class GCD, template< class, typename, bool > class CHKOP>
  NumberType & operator*= (NumberType &n, const Rational< T, GCD, CHKOP > &o)
- template<typename T , template< typename, bool, template< class, typename, bool > class, template< typename > class > class GCD, template< class, typename, bool > class CHKOP, typename NumberType >
  Rational< T, GCD, CHKOP > operator* (const Rational< T, GCD, CHKOP > &o, const NumberType &n)
- template<typename NumberType , typename T , template< typename, bool, template< class, typename, bool > class, template< typename > class > class GCD, template< class, typename, bool > class CHKOP>
  Rational< T, GCD, CHKOP > operator* (const NumberType &n, const Rational< T, GCD, CHKOP > &o)
- template<typename NumberType , typename T , template< typename, bool, template< class, typename, bool > class, template< typename > class > class GCD, template< class, typename, bool > class CHKOP>
  NumberType & operator/= (NumberType &n, const Rational< T, GCD, CHKOP > &o)
- template<typename T , template< typename, bool, template< class, typename, bool > class, template< typename > class > class GCD, template< class, typename, bool > class CHKOP, typename NumberType >
  Rational< T, GCD, CHKOP > operator/ (const Rational< T, GCD, CHKOP > &o, const NumberType &n)
- template<typename NumberType , typename T , template< typename, bool, template< class, typename, bool > class, template< typename > class > class GCD, template< class, typename, bool > class CHKOP>
  Rational< T, GCD, CHKOP > operator/ (const NumberType &n, const Rational< T, GCD, CHKOP > &o)
- template<typename NumberType , typename T , template< typename, bool, template< class, typename, bool > class, template< typename > class > class GCD, template< class, typename, bool > class CHKOP>
  NumberType & operator%= (NumberType &n, const Rational< T, GCD, CHKOP > &o)
- template<typename T , template< typename, bool, template< class, typename, bool > class, template< typename > class > class GCD, template< class, typename, bool > class CHKOP, typename NumberType >
  Rational< T, GCD, CHKOP > operator% (const Rational< T, GCD, CHKOP > &o, const NumberType &n)
- template<typename NumberType , typename T , template< typename, bool, template< class, typename, bool > class, template< typename > class > class GCD, template< class, typename, bool > class CHKOP>
  Rational< T, GCD, CHKOP > operator% (const NumberType &n, const Rational< T, GCD, CHKOP > &o)
- template<typename NumberType , typename T , template< typename, bool, template< class, typename, bool > class, template< typename > class > class GCD, template< class, typename, bool > class CHKOP>
  bool operator== (const NumberType &n, const Rational< T, GCD, CHKOP > &o)
- template<typename T , template< typename, bool, template< class, typename, bool > class, template< typename > class > class GCD, template< class, typename, bool > class CHKOP, typename NumberType >
  bool operator== (const Rational< T, GCD, CHKOP > &o, const NumberType &n)
- template<typename NumberType , typename T , template< typename, bool, template< class, typename, bool > class, template< typename > class > class GCD, template< class, typename, bool > class CHKOP>
  bool operator!= (const NumberType &n, const Rational< T, GCD, CHKOP > &o)
- template<typename T , template< typename, bool, template< class, typename, bool > class, template< typename > class > class GCD, template< class, typename, bool > class CHKOP, typename NumberType >
  bool operator!= (const Rational< T, GCD, CHKOP > &o, const NumberType &n)
- template<typename NumberType , typename T , template< typename, bool, template< class, typename, bool > class, template< typename > class > class GCD, template< class, typename, bool > class CHKOP>
  bool operator< (const NumberType &n, const Rational< T, GCD, CHKOP > &o)
- template<typename T , template< typename, bool, template< class, typename, bool > class, template< typename > class > class GCD, template< class, typename, bool > class CHKOP, typename NumberType >
  bool operator< (const Rational< T, GCD, CHKOP > &o, const NumberType &n)
- template<typename NumberType , typename T , template< typename, bool, template< class, typename, bool > class, template< typename > class > class GCD, template< class, typename, bool > class CHKOP>
  bool operator<= (const NumberType &n, const Rational< T, GCD, CHKOP > &o)
- template<typename T , template< typename, bool, template< class, typename, bool > class, template< typename > class > class GCD, template< class, typename, bool > class CHKOP, typename NumberType >
  bool operator<= (const Rational< T, GCD, CHKOP > &o, const NumberType &n)
- template<typename NumberType , typename T , template< typename, bool, template< class, typename, bool > class, template< typename > class > class GCD, template< class, typename, bool > class CHKOP>
  bool operator> (const NumberType &n, const Rational< T, GCD, CHKOP > &o)

- template<typename T , template< typename, bool, template< class, typename, bool > class, template< typename > class > class GCD, template< class, typename, bool > class CHKOP, typename NumberType >
  bool operator> (const Rational< T, GCD, CHKOP > &o, const NumberType &n)
- template<typename NumberType , typename T , template< typename, bool, template< class, typename, bool > class, template< typename > class > class GCD, template< class, typename, bool > class CHKOP>
  bool operator>= (const NumberType &n, const Rational< T, GCD, CHKOP > &o)
- template<typename T , template< typename, bool, template< class, typename, bool > class, template< typename > class > class GCD, template< class, typename, bool > class CHKOP, typename NumberType >
  bool operator>= (const Rational< T, GCD, CHKOP > &o, const NumberType &n)

4.9.1 Detailed Description

template<typename T, template< typename, bool, template< class, typename, bool > class, template< typename > class > class GCD = GCD_euclid_fast, template< class, typename=T, bool=std::numeric_limits< T >::is_signed > class CHKOP = NO_OPERATOR_CHECK>class Commons::Math::Rational< T, GCD, CHKOP >

Rational (fraction) template class

Note

All Rational objects are reduced (see Greatest common divisor algorithms)

Template Parameters

T	storage type
GCD	GCD algorithm
CHKOP	checked operator

See also

ENABLE_OVERFLOW_CHECK

4.9.2 Member Typedef Documentation

4.9.2.1 template<typename T , template< typename, bool, template< class, typename, bool > class, template< typename > class > class GCD = GCD_euclid_fast, template< class, typename=T, bool=std::numeric_limits< T >::is_signed > class CHKOP = NO_OPERATOR_CHECK> typedef T Commons::Math::Rational< T, GCD, CHKOP >::integer_type

storage type

4.9.2.2 template<typename T , template< typename, bool, template< class, typename, bool > class, template< typename > class > class GCD = GCD_euclid_fast, template< class, typename=T, bool=std::numeric_limits< T >::is_signed > class CHKOP = NO_OPERATOR_CHECK> typedef _mod<integer_type, GCD, CHKOP, std::numeric_limits<integer_type>::is_signed>::pair_type Commons::Math::Rational< T, GCD, CHKOP >::mod_type

type of the return value of mod()

This type is based on `std::pair`, where `first` is the integral value and `second` the fractional part

4.9.2.3 template<typename T , template< typename, bool, template< class, typename, bool > class, template< typename > class > class GCD = GCD_euclid_fast, template< class, typename=T, bool=std::numeric_limits< T >::is_signed > class CHKOP = NO_OPERATOR_CHECK> typedef CHKOP<std::divides<T> > Commons::Math::Rational< T, GCD, CHKOP >::op_divides

division (`a / b`) operator

4.9.2.4 template<typename T , template< typename, bool, template< class, typename, bool > class, template< typename > class > class GCD = GCD_euclid_fast, template< class, typename=T, bool=std::numeric_limits< T >::is_signed > class CHKOP = NO_OPERATOR_CHECK> typedef CHKOP<std::minus<T> > Commons::Math::Rational< T, GCD, CHKOP >::op_minus

subtraction (a - b) operator

4.9.2.5 template<typename T , template< typename, bool, template< class, typename, bool > class, template< typename > class > class GCD = GCD_euclid_fast, template< class, typename=T, bool=std::numeric_limits< T >::is_signed > class CHKOP = NO_OPERATOR_CHECK> typedef CHKOP<std::modulus<T> > Commons::Math::Rational< T, GCD, CHKOP >::op_modulus

modulus (a % b) operator

4.9.2.6 template<typename T , template< typename, bool, template< class, typename, bool > class, template< typename > class > class GCD = GCD_euclid_fast, template< class, typename=T, bool=std::numeric_limits< T >::is_signed > class CHKOP = NO_OPERATOR_CHECK> typedef CHKOP<std::multiplies<T> > Commons::Math::Rational< T, GCD, CHKOP >::op_multiplies

multiplication (a * b) operator

4.9.2.7 template<typename T , template< typename, bool, template< class, typename, bool > class, template< typename > class > class GCD = GCD_euclid_fast, template< class, typename=T, bool=std::numeric_limits< T >::is_signed > class CHKOP = NO_OPERATOR_CHECK> typedef CHKOP<std::negate<T> > Commons::Math::Rational< T, GCD, CHKOP >::op_negate

subtraction (a - b) operator

4.9.2.8 template<typename T , template< typename, bool, template< class, typename, bool > class, template< typename > class > class GCD = GCD_euclid_fast, template< class, typename=T, bool=std::numeric_limits< T >::is_signed > class CHKOP = NO_OPERATOR_CHECK> typedef CHKOP<std::plus<T> > Commons::Math::Rational< T, GCD, CHKOP >::op_plus

addition (a + b) operator

4.9.3 Constructor & Destructor Documentation

4.9.3.1 template<typename T , template< typename, bool, template< class, typename, bool > class, template< typename > class > class GCD = GCD_euclid_fast, template< class, typename=T, bool=std::numeric_limits< T >::is_signed > class CHKOP = NO_OPERATOR_CHECK> Commons::Math::Rational< T, GCD, CHKOP >::Rational ( ) [inline]

creates a default (null) Rational

Creates a fraction $\frac{0}{1}$

4.9.3.2 template<typename T , template< typename, bool, template< class, typename, bool > class, template< typename > class > class GCD, template< class, typename, bool > class CHKOP> Commons::Math::Rational< T, GCD, CHKOP >::Rational (const Rational< T, GCD, CHKOP > & *other*)

copy constructor

Parameters

in	*other*	the Rational to copy

4.9.3.3 template<typename T , template< typename, bool, template< class, typename, bool > class, template< typename > class > class GCD = GCD_euclid_fast, template< class, typename=T, bool=std::numeric_limits< T >::is_signed > class CHKOP = NO_OPERATOR_CHECK> template<template< typename, bool, template< class, typename, bool > class, template< typename > class > class U1, template< class, typename, bool > class V1, template< typename, bool, template< class, typename, bool > class, template< typename > class > class U2, template< class, typename, bool > class V2> Commons::Math::Rational< T, GCD, CHKOP >::Rational (const Rational< integer_type, U1, V1 > & *numer,* const Rational< integer_type, U2, V2 > & *denom*) [inline]

creates a Rational

Creates a copy of `numer` and divides it by `denom`

Note

to achieve a continued faction like $\frac{1}{\frac{1}{2}}$ you must explicitely cast the *numerator*, i.e.

```
const Rational<rational_type> x ( Rational<rational_type> ( 1 ),
 Rational<rational_type> ( 1,2 ));
```

Template Parameters

U1	GCD algorithm of the numerator
V1	operator checker of the numerator
U2	GCD algorithm of the denominator
V2	operator checker of the denominator

Parameters

in	*numer*	the numerator
in	*denom*	the denominator

4.9.3.4 template<typename T , template< typename, bool, template< class, typename, bool > class, template< typename > class > class GCD, template< class, typename, bool > class CHKOP> Commons::Math::Rational< T, GCD, CHKOP >::Rational (const integer_type & *numer,* const integer_type & *denom*)

creates a Rational

Creates a fraction $\frac{numer}{denom}$

Parameters

in	*numer*	the numerator
in	*denom*	the denominator

4.9.3.5 template<typename T , template< typename, bool, template< class, typename, bool > class, template< typename > class > class GCD = GCD_euclid_fast, template< class, typename=T, bool=std::numeric_limits< T >::is_signed > class CHKOP = NO_OPERATOR_CHECK> Commons::Math::Rational< T, GCD, CHKOP >::Rational (const integer_type & *whole,* const integer_type & *numer,* const integer_type & *denom*) [inline]

creates a inproper (mixed) Rational

Creates a fraction $whole + \frac{numer}{denom}$

Parameters

in	*whole*	whole number part
in	*numer*	the numerator
in	*denom*	the denominator

4.9.3.6 template<typename T , template< typename, bool, template< class, typename, bool > class, template< typename > class > class GCD, template< class, typename, bool > class CHKOP> template<typename NumberType> Commons::Math::Rational< T, GCD, CHKOP >::Rational (const NumberType & *number*)

creates an approximated Rational

Example:
`Commons::Math::Rational<uint64_t>`(std::sqrt(2.0l)) to get $\sqrt{2} \approx \frac{6333631924}{4478554083}$

See also

Commons::Math::EPSILON to control the quality of the approximation

Template Parameters

NumberType	type of the number to approximate

Parameters

in	*number*	the number to create an approximated Rational of

4.9.3.7 template<typename T , template< typename, bool, template< class, typename, bool > class, template< typename > class > class GCD, template< class, typename, bool > class CHKOP> Commons::Math::Rational< T, GCD, CHKOP >::Rational (const char * *expr*)

creates a Rational approximated by an expression

If `expr` is not `null` and not empty then it is parsed and evaluated as `long double` expression and approximated to a fraction.

The *expression* can be a simple infix arithmetic expression containing

- addition (+); also *unary*
- subtraction (−); also *unary*
- multiplication (∗)
- division (/)
- parenthesises

Numbers can be integers or floats in non-scientific notation. Allowed are spaces and tabs around numbers, parenthesises and operators.

The expression gets evaluated into an `long double` value and is than approximated to a fraction.

In case of errors an `std::runtime_exception` is thrown if exceptions are enabled, else the result is undefined.

Example:

```
Rational<long> x ( "(11/2) * +(4.25+3.75)" );
```

produces the fraction $x = \frac{44}{1}$

See also

Rational(const NumberType &number)

Parameters

in	*expr*	the expression to evaluate and approximate

4.9.4 Member Function Documentation

4.9.4.1 template<typename T , template< typename, bool, template< class, typename, bool > class, template< typename > class > class GCD = GCD_euclid_fast, template< class, typename=T, bool=std::numeric_limits< T >::is_signed > class CHKOP = NO_OPERATOR_CHECK> Rational Commons::Math::Rational< T, GCD, CHKOP >::abs ( ) const [inline]

gets the absolute Rational

Returns for *signed* types (this->numerator() < T() ? -(*this) : (*this)) and for *unsigned* types (*this)

Returns

a copy of the absolute Rational

4.9.4.2 template<typename T , template< typename, bool, template< class, typename, bool > class, template< typename > class > class GCD = GCD_euclid_fast, template< class, typename=T, bool=std::numeric_limits< T >::is_signed > class CHKOP = NO_OPERATOR_CHECK> integer_type Commons::Math::Rational< T, GCD, CHKOP >::denominator ( ) const [inline]

gets the denominator

Returns

the denominator

4.9.4.3 template<typename T , template< typename, bool, template< class, typename, bool > class, template< typename > class > class GCD, template< class, typename, bool > class CHKOP> Rational< T, GCD, CHKOP > Commons::Math::Rational< T, GCD, CHKOP >::inverse ( ) const

gets a copy of the inverted Rational

See also

invert()

Returns

a copy of the inverted Rational

4.9.4.4 template<typename T , template< typename, bool, template< class, typename, bool > class, template< typename > class > class GCD, template< class, typename, bool > class CHKOP> Rational< T, GCD, CHKOP > & Commons::Math::Rational< T, GCD, CHKOP >::invert ( )

inverts the Rational

Example:
$\frac{-5}{12}$ will become to $\frac{-12}{5}$

Returns

the inverted Rational

4.9.4.5 template<typename T , template< typename, bool, template< class, typename, bool > class, template< typename > class > class GCD, template< class, typename, bool > class CHKOP> Rational< T, GCD, CHKOP >::mod_type Commons::Math::Rational< T, GCD, CHKOP >::mod ( ) const

extract the integral and fractional part

See also

mod_type

Returns

a `mod_type` containing the integral and fractional part

4.9.4.6 template<typename T , template< typename, bool, template< class, typename, bool > class, template< typename > class > class GCD = GCD_euclid_fast, template< class, typename=T, bool=std::numeric_limits< T >::is_signed > class CHKOP = NO_OPERATOR_CHECK> integer_type Commons::Math::Rational< T, GCD, CHKOP >::numerator ( ) const [inline]

gets the numerator

Returns

the numerator

4.9.4.7 template<typename T , template< typename, bool, template< class, typename, bool > class, template< typename > class > class GCD = GCD_euclid_fast, template< class, typename=T, bool=std::numeric_limits< T >::is_signed > class CHKOP = NO_OPERATOR_CHECK> template<typename NumberType > Commons::Math::Rational< T, GCD, CHKOP >::operator NumberType ( ) const [inline]

convert to `NumberType`

Template Parameters

NumberType	type of the number to approximate

Returns

the number value of the Rational

4.9.4.8 template<typename T , template< typename, bool, template< class, typename, bool > class, template< typename > class > class GCD = GCD_euclid_fast, template< class, typename=T, bool=std::numeric_limits< T >::is_signed > class CHKOP = NO_OPERATOR_CHECK> bool Commons::Math::Rational< T, GCD, CHKOP >::operator! ( ) const [inline]

test if it is the neutral element to addition and subtraction

Tests if the `numerator` is equal to the default constructed `integer_type`

Note

$0 + x = x + 0 = x$ and $0 - x = x - 0 = x$

Warning

it does **not** do the test for the neutral element to multiplication and division

Returns

`true` if it is the neutral element to addition and subtraction, `false` otherwise

4.9.4.9 template<typename T , template< typename, bool, template< class, typename, bool > class, template< typename > class > class GCD = GCD_euclid_fast, template< class, typename=T, bool=std::numeric_limits< T >::is_signed > class CHKOP = NO_OPERATOR_CHECK> bool Commons::Math::Rational< T, GCD, CHKOP >::operator!= (const Rational< T, GCD, CHKOP > & *other*) const [inline]

test on inequality

Parameters

in	*other*	the Rational to test to

Returns

`true` if not equal, `false` otherwise

4.9.4.10 template<typename T , template< typename, bool, template< class, typename, bool > class, template< typename > class > class GCD = GCD_euclid_fast, template< class, typename=T, bool=std::numeric_limits< T >::is_signed > class CHKOP = NO_OPERATOR_CHECK> Rational Commons::Math::Rational< T, GCD, CHKOP >::operator% (const Rational< T, GCD, CHKOP > & *other*) const [inline]

modulo a Rational

Parameters

in	*other*	the Rational to modulo

Returns

a new Rational

4.9.4.11 template<typename T , template< typename, bool, template< class, typename, bool > class, template< typename > class > class GCD, template< class, typename, bool > class CHKOP> Rational< T, GCD, CHKOP > & Commons::Math::Rational< T, GCD, CHKOP >::operator%= (const Rational< T, GCD, CHKOP > & *other*)

modulo and assign a Rational

Parameters

in	*other*	the Rational to modulo and assign

Returns

the Rational

4.9.4.12 template<typename T , template< typename, bool, template< class, typename, bool > class, template< typename > class > class GCD, template< class, typename, bool > class CHKOP> Rational< T, GCD, CHKOP > Commons::Math::Rational< T, GCD, CHKOP >::operator* (const Rational< T, GCD, CHKOP > & *other*) const

multiply a Rational

Parameters

in	*other*	the Rational to multiply

Returns

a new Rational

4.9.4.13 template<typename T , template< typename, bool, template< class, typename, bool > class, template< typename > class > class GCD, template< class, typename, bool > class CHKOP> Rational< T, GCD, CHKOP > & Commons::Math::Rational< T, GCD, CHKOP >::operator*= (const Rational< T, GCD, CHKOP > & *other*)

multiply and assign a Rational

Parameters

in	*other*	the Rational to multiply and assign

Returns

the Rational

4.9.4.14 template<typename T , template< typename, bool, template< class, typename, bool > class, template< typename > class > class GCD, template< class, typename, bool > class CHKOP> Rational< T, GCD, CHKOP > Commons::Math::Rational< T, GCD, CHKOP >::operator+ (const Rational< T, GCD, CHKOP > & *other*) const

add a Rational

Parameters

in	*other*	the Rational to add

Returns

a new Rational

4.9.4.15 template<typename T , template< typename, bool, template< class, typename, bool > class, template< typename > class > class GCD = GCD_euclid_fast, template< class, typename=T, bool=std::numeric_limits< T >::is_signed > class CHKOP = NO_OPERATOR_CHECK> Rational Commons::Math::Rational< T, GCD, CHKOP >::operator+ ( ) const [inline]

get a copy of the Rational

Returns

a copy of Rational

4.9.4.16 template<typename T , template< typename, bool, template< class, typename, bool > class, template< typename > class > class GCD = GCD_euclid_fast, template< class, typename=T, bool=std::numeric_limits< T >::is_signed > class CHKOP = NO_OPERATOR_CHECK> Rational& Commons::Math::Rational< T, GCD, CHKOP >::operator++ ( ) [inline]

pre-increment a Rational

the result will be $\frac{numerator+denominator}{denominator} \Rightarrow numerator + 1$

Returns

the incremented Rational

4.9.4.17 template<typename T , template< typename, bool, template< class, typename, bool > class, template< typename > class > class GCD = GCD_euclid_fast, template< class, typename=T, bool=std::numeric_limits< T >::is_signed > class CHKOP = NO_OPERATOR_CHECK> Rational Commons::Math::Rational< T, GCD, CHKOP >::operator++ (int) [inline]

post-increment a Rational

See also

operator++()

Returns

a copy of Rational

4.9.4.18 template<typename T , template< typename, bool, template< class, typename, bool > class, template< typename > class > class GCD = GCD_euclid_fast, template< class, typename=T, bool=std::numeric_limits< T >::is_signed > class CHKOP = NO_OPERATOR_CHECK> Rational& Commons::Math::Rational< T, GCD, CHKOP >::operator+= (const Rational< T, GCD, CHKOP > & *other*) [inline]

add and assign a Rational

Parameters

in	*other*	the Rational to add and assign

Returns

the Rational

4.9.4.19 template<typename T , template< typename, bool, template< class, typename, bool > class, template< typename > class > class GCD = GCD_euclid_fast, template< class, typename=T, bool=std::numeric_limits< T >::is_signed > class CHKOP = NO_OPERATOR_CHECK> Rational Commons::Math::Rational< T, GCD, CHKOP >::operator- (const Rational< T, GCD, CHKOP > & *other*) const [inline]

subtract a Rational

Parameters

in	*other*	the Rational to subtract

Returns

a new Rational

4.9.4.20 template<typename T , template< typename, bool, template< class, typename, bool > class, template< typename > class > class GCD = GCD_euclid_fast, template< class, typename=T, bool=std::numeric_limits< T >::is_signed > class CHKOP = NO_OPERATOR_CHECK> Rational Commons::Math::Rational< T, GCD, CHKOP >::operator- ( ) const [inline]

get a negated copy of the Rational

Returns

a negated copy of Rational

4.9.4.21 template<typename T , template< typename, bool, template< class, typename, bool > class, template< typename > class > class GCD = GCD_euclid_fast, template< class, typename=T, bool=std::numeric_limits< T >::is_signed > class CHKOP = NO_OPERATOR_CHECK> Rational& Commons::Math::Rational< T, GCD, CHKOP >::operator-- ( ) [inline]

pre-decrement a Rational

the result will be $\frac{numerator-denominator}{denominator} \Rightarrow numerator - 1$

Returns

the incremented Rational

4.9.4.22 template<typename T , template< typename, bool, template< class, typename, bool > class, template< typename > class > class GCD = GCD_euclid_fast, template< class, typename=T, bool=std::numeric_limits< T >::is_signed > class CHKOP = NO_OPERATOR_CHECK> Rational Commons::Math::Rational< T, GCD, CHKOP >::operator-- (int) [inline]

post-decrement a Rational

See also

operator--()

Returns

a copy of Rational

4.9.4.23 template<typename T , template< typename, bool, template< class, typename, bool > class, template< typename > class > class GCD = GCD_euclid_fast, template< class, typename=T, bool=std::numeric_limits< T >::is_signed > class CHKOP = NO_OPERATOR_CHECK> Rational& Commons::Math::Rational< T, GCD, CHKOP >::operator-= (const Rational< T, GCD, CHKOP > & *other*) [inline]

subtract and assign a Rational

Parameters

in	*other*	the Rational to subtract and assign

Returns

the Rational

4.9.4.24 template<typename T , template< typename, bool, template< class, typename, bool > class, template< typename > class > class GCD = GCD_euclid_fast, template< class, typename=T, bool=std::numeric_limits< T >::is_signed > class CHKOP = NO_OPERATOR_CHECK> Rational Commons::Math::Rational< T, GCD, CHKOP >::operator/ (const Rational< T, GCD, CHKOP > & *other*) const [inline]

divide a Rational

Parameters

in	*other*	the Rational to divide

Returns

a new Rational

4.9.4.25 template<typename T , template< typename, bool, template< class, typename, bool > class, template< typename > class > class GCD = GCD_euclid_fast, template< class, typename=T, bool=std::numeric_limits< T >::is_signed > class CHKOP = NO_OPERATOR_CHECK> Rational& Commons::Math::Rational< T, GCD, CHKOP >::operator/= (const Rational< T, GCD, CHKOP > & *other*) [inline]

divide and assign a Rational

Parameters

in	*other*	the Rational to divide and assign

Returns

the Rational

4.9.4.26 template<typename T , template< typename, bool, template< class, typename, bool > class, template< typename > class > class GCD, template< class, typename, bool > class CHKOP> bool Commons::Math::Rational< T, GCD, CHKOP >::operator< (const Rational< T, GCD, CHKOP > & *other*) const

test if less than

Parameters

in	*other*	the Rational to test to

Returns

`true` if less than `other`, `false` otherwise

4.9.4.27 template<typename T , template< typename, bool, template< class, typename, bool > class, template< typename > class > class GCD = GCD_euclid_fast, template< class, typename=T, bool=std::numeric_limits< T >::is_signed > class CHKOP = NO_OPERATOR_CHECK> bool Commons::Math::Rational< T, GCD, CHKOP >::operator<= (const Rational< T, GCD, CHKOP > & *other*) const [inline]

test if less or equal than

Parameters

in	*other*	the Rational to test to

Returns

`true` if less or equal than `other`, `false` otherwise

4.9.4.28 template<typename T , template< typename, bool, template< class, typename, bool > class, template< typename > class > class GCD = GCD_euclid_fast, template< class, typename=T, bool=std::numeric_limits< T >::is_signed > class CHKOP = NO_OPERATOR_CHECK> Rational& Commons::Math::Rational< T, GCD, CHKOP >::operator= (const Rational< T, GCD, CHKOP > & *another*) [inline]

assign another Rational

Parameters

in	*another*	the Rational to assign

4.9.4.29 template<typename T , template< typename, bool, template< class, typename, bool > class, template< typename > class > class GCD = GCD_euclid_fast, template< class, typename=T, bool=std::numeric_limits< T >::is_signed > class CHKOP = NO_OPERATOR_CHECK> template<typename NumberType > Rational& Commons::Math::Rational< T, GCD, CHKOP >::operator= (const NumberType & *number*) [inline]

assigns from a `NumberType`

The `number` is approximated to a Rational, then it gets assigned

See also

Rational(const NumberType &number)
Commons::Math::EPSILON

Template Parameters

NumberType	type of the number to approximate

Parameters

in	*number*	the number to assign

4.9.4.30 template<typename T , template< typename, bool, template< class, typename, bool > class, template< typename > class > class GCD = GCD_euclid_fast, template< class, typename=T, bool=std::numeric_limits< T >::is_signed > class CHKOP = NO_OPERATOR_CHECK> bool Commons::Math::Rational< T, GCD, CHKOP >::operator== (const Rational< T, GCD, CHKOP > & *other*) const [inline]

test on equality

Parameters

in	*other*	the Rational to test to

Returns

`true` if equal, `false` otherwise

4.9.4.31 template<typename T , template< typename, bool, template< class, typename, bool > class, template< typename > class > class GCD = GCD_euclid_fast, template< class, typename=T, bool=std::numeric_limits< T >::is_signed > class CHKOP = NO_OPERATOR_CHECK> bool Commons::Math::Rational< T, GCD, CHKOP >::operator> (const Rational< T, GCD, CHKOP > & *other*) const [inline]

test if greater than

Parameters

in	*other*	the Rational to test to

Returns

`true` if greater than `other`, `false` otherwise

4.9.4.32 template<typename T , template< typename, bool, template< class, typename, bool > class, template< typename > class > class GCD = GCD_euclid_fast, template< class, typename=T, bool=std::numeric_limits< T >::is_signed > class CHKOP = NO_OPERATOR_CHECK> bool Commons::Math::Rational< T, GCD, CHKOP >::operator>= (const Rational< T, GCD, CHKOP > & *other*) const [inline]

test if greater or equal than

Parameters

in	*other*	the Rational to test to

Returns

`true` if greater or equal than `other`, `false` otherwise

4.9.4.33 template<typename T , template< typename, bool, template< class, typename, bool > class, template< typename > class > class GCD, template< class, typename, bool > class CHKOP> std::string Commons::Math::Rational< T, GCD, CHKOP >::str (bool *mixed* = `false`) const

generates the string representation of Rational

Parameters

in	*mixed*	if `true`, than a mixed (inproper) fraction is generated

Returns

the string representation of Rational

4.9.5 Friends And Related Function Documentation

4.9.5.1 template<typename NumberType , typename T , template< typename, bool, template< class, typename, bool > class, template< typename > class > class GCD, template< class, typename, bool > class CHKOP> bool operator!= (const NumberType & *n,* const Rational< T, GCD, CHKOP > & *o*) [related]

Template Parameters

NumberType	the number type
T	the storage type
GCD	the GCD algorithm
CHKOP	checked operator

See also

ENABLE_OVERFLOW_CHECK

4.9.5.2 template<typename T , template< typename, bool, template< class, typename, bool > class, template< typename > class > class GCD, template< class, typename, bool > class CHKOP, typename NumberType > bool operator!= (const Rational< T, GCD, CHKOP > & *o,* const NumberType & *n*) [related]

Template Parameters

T	the storage type
GCD	the GCD algorithm
NumberType	the number type
CHKOP	checked operator

See also

ENABLE_OVERFLOW_CHECK

4.9.5.3 template<typename T , template< typename, bool, template< class, typename, bool > class, template< typename > class > class GCD, template< class, typename, bool > class CHKOP, typename NumberType > Rational< T, GCD, CHKOP > operator% (const Rational< T, GCD, CHKOP > & *o,* const NumberType & *n*) [related]

Template Parameters

T	the storage type
GCD	the GCD algorithm
NumberType	the number type
CHKOP	checked operator

See also

ENABLE_OVERFLOW_CHECK

4.9.5.4 template<typename NumberType , typename T , template< typename, bool, template< class, typename, bool > class, template< typename > class > class GCD, template< class, typename, bool > class CHKOP> Rational< T, GCD, CHKOP > operator% (const NumberType & *n*, const Rational< T, GCD, CHKOP > & *o*) [related]

Template Parameters

NumberType	the number type
T	the storage type
GCD	the GCD algorithm
CHKOP	checked operator

See also

ENABLE_OVERFLOW_CHECK

4.9.5.5 template<typename NumberType , typename T , template< typename, bool, template< class, typename, bool > class, template< typename > class > class GCD, template< class, typename, bool > class CHKOP> NumberType & operator%= (NumberType & *n*, const Rational< T, GCD, CHKOP > & *o*) [related]

Template Parameters

NumberType	the number type
T	the storage type
GCD	the GCD algorithm
CHKOP	checked operator

See also

ENABLE_OVERFLOW_CHECK

4.9.5.6 template<typename T , template< typename, bool, template< class, typename, bool > class, template< typename > class > class GCD, template< class, typename, bool > class CHKOP, typename NumberType > Rational< T, GCD, CHKOP > operator* (const Rational< T, GCD, CHKOP > & *o*, const NumberType & *n*) [related]

Template Parameters

T	the storage type
GCD	the GCD algorithm
NumberType	the number type

CHKOP	checked operator

See also

ENABLE_OVERFLOW_CHECK

4.9.5.7 template<typename NumberType , typename T , template< typename, bool, template< class, typename, bool > class, template< typename > class > class GCD, template< class, typename, bool > class CHKOP> Rational< T, GCD, CHKOP > operator∗ (const NumberType & *n*, const Rational< T, GCD, CHKOP > & *o*) [related]

Template Parameters

NumberType	the number type
T	the storage type
GCD	the GCD algorithm
CHKOP	checked operator

See also

ENABLE_OVERFLOW_CHECK

4.9.5.8 template<typename NumberType , typename T , template< typename, bool, template< class, typename, bool > class, template< typename > class > class GCD, template< class, typename, bool > class CHKOP> NumberType & operator∗= (NumberType & *n*, const Rational< T, GCD, CHKOP > & *o*) [related]

Template Parameters

NumberType	the number type
T	the storage type
GCD	the GCD algorithm
CHKOP	checked operator

See also

ENABLE_OVERFLOW_CHECK

4.9.5.9 template<typename T , template< typename, bool, template< class, typename, bool > class, template< typename > class > class GCD, template< class, typename, bool > class CHKOP, typename NumberType > Rational< T, GCD, CHKOP > operator+ (const Rational< T, GCD, CHKOP > & *o*, const NumberType & *n*) [related]

Template Parameters

T	the storage type
GCD	the GCD algorithm
NumberType	the number type
CHKOP	checked operator

See also

ENABLE_OVERFLOW_CHECK

4.9.5.10 template<typename NumberType , typename T , template< typename, bool, template< class, typename, bool > class, template< typename > class > class GCD, template< class, typename, bool > class CHKOP> Rational< T, GCD, CHKOP > operator+ (const NumberType & *n*, const Rational< T, GCD, CHKOP > & *o*) [related]

Template Parameters

NumberType	the number type
T	the storage type
GCD	the GCD algorithm
CHKOP	checked operator

See also

ENABLE_OVERFLOW_CHECK

4.9.5.11 template<typename NumberType , typename T , template< typename, bool, template< class, typename, bool > class, template< typename > class > class GCD, template< class, typename, bool > class CHKOP> NumberType & operator+= (NumberType & *n,* const Rational< T, GCD, CHKOP > & *o*) [related]

Template Parameters

NumberType	the number type
T	the storage type
GCD	the GCD algorithm
CHKOP	checked operator

See also

ENABLE_OVERFLOW_CHECK

4.9.5.12 template<typename T , template< typename, bool, template< class, typename, bool > class, template< typename > class > class GCD, template< class, typename, bool > class CHKOP, typename NumberType > Rational< T, GCD, CHKOP > operator- (const Rational< T, GCD, CHKOP > & *o,* const NumberType & *n*) [related]

Template Parameters

T	the storage type
GCD	the GCD algorithm
NumberType	the number type
CHKOP	checked operator

See also

ENABLE_OVERFLOW_CHECK

4.9.5.13 template<typename NumberType , typename T , template< typename, bool, template< class, typename, bool > class, template< typename > class > class GCD, template< class, typename, bool > class CHKOP> Rational< T, GCD, CHKOP > operator- (const NumberType & *n,* const Rational< T, GCD, CHKOP > & *o*) [related]

Template Parameters

NumberType	the number type
T	the storage type
GCD	the GCD algorithm

CHKOP	checked operator

See also

ENABLE_OVERFLOW_CHECK

4.9.5.14 template<typename NumberType , typename T , template< typename, bool, template< class, typename, bool > class, template< typename > class > class GCD, template< class, typename, bool > class CHKOP> NumberType & operator-= (NumberType & *n,* const **Rational**< T, GCD, CHKOP > & *o*) [related]

Template Parameters

NumberType	the number type
T	the storage type
GCD	the GCD algorithm
CHKOP	checked operator

See also

ENABLE_OVERFLOW_CHECK

4.9.5.15 template<typename T , template< typename, bool, template< class, typename, bool > class, template< typename > class > class GCD, template< class, typename, bool > class CHKOP, typename NumberType > **Rational**< T, GCD, CHKOP > operator/ (const **Rational**< T, GCD, CHKOP > & *o,* const NumberType & *n*) [related]

Template Parameters

T	the storage type
GCD	the GCD algorithm
NumberType	the number type
CHKOP	checked operator

See also

ENABLE_OVERFLOW_CHECK

4.9.5.16 template<typename NumberType , typename T , template< typename, bool, template< class, typename, bool > class, template< typename > class > class GCD, template< class, typename, bool > class CHKOP> **Rational**< T, GCD, CHKOP > operator/ (const NumberType & *n,* const **Rational**< T, GCD, CHKOP > & *o*) [related]

Template Parameters

NumberType	the number type
T	the storage type
GCD	the GCD algorithm
CHKOP	checked operator

See also

ENABLE_OVERFLOW_CHECK

4.9.5.17 template<typename NumberType , typename T , template< typename, bool, template< class, typename, bool > class, template< typename > class > class GCD, template< class, typename, bool > class CHKOP> NumberType & operator/= (NumberType & *n,* const **Rational**< T, GCD, CHKOP > & *o*) [related]

Template Parameters

NumberType	the number type
T	the storage type
GCD	the GCD algorithm
CHKOP	checked operator

See also

ENABLE_OVERFLOW_CHECK

4.9.5.18 template<typename NumberType , typename T , template< typename, bool, template< class, typename, bool > class, template< typename > class > class GCD, template< class, typename, bool > class CHKOP> bool operator< (const NumberType & *n,* const Rational< T, GCD, CHKOP > & *o*) [related]

Template Parameters

NumberType	the number type
T	the storage type
GCD	the GCD algorithm
CHKOP	checked operator

See also

ENABLE_OVERFLOW_CHECK

4.9.5.19 template<typename T , template< typename, bool, template< class, typename, bool > class, template< typename > class > class GCD, template< class, typename, bool > class CHKOP, typename NumberType > bool operator< (const Rational< T, GCD, CHKOP > & *o,* const NumberType & *n*) [related]

Template Parameters

T	the storage type
GCD	the GCD algorithm
NumberType	the number type
CHKOP	checked operator

See also

ENABLE_OVERFLOW_CHECK

4.9.5.20 template<typename T , template< typename, bool, template< class, typename, bool > class, template< typename > class > class GCD = GCD_euclid_fast, template< class, typename=T, bool=std::numeric_limits< T >::is_signed > class CHKOP = NO_OPERATOR_CHECK> std::ostream& operator<< (std::ostream & *o,* const Rational< T, GCD, CHKOP > & *r*) [friend]

output stream operator

Sends a string representation of Rational to a `std::ostream`

See also

str(bool)

Parameters

out	*o*	the stream to send to
in	*r*	the Rational to send to the stream o

Returns

the stream o

4.9.5.21 template<typename NumberType , typename T , template< typename, bool, template< class, typename, bool > class, template< typename > class > class GCD, template< class, typename, bool > class CHKOP> bool operator<= (const NumberType & *n,* const Rational< T, GCD, CHKOP > & *o*) [related]

Template Parameters

NumberType	the number type
T	the storage type
GCD	the GCD algorithm
CHKOP	checked operator

See also

ENABLE_OVERFLOW_CHECK

4.9.5.22 template<typename T , template< typename, bool, template< class, typename, bool > class, template< typename > class > class GCD, template< class, typename, bool > class CHKOP, typename NumberType > bool operator<= (const Rational< T, GCD, CHKOP > & *o,* const NumberType & *n*) [related]

Template Parameters

T	the storage type
GCD	the GCD algorithm
NumberType	the number type
CHKOP	checked operator

See also

ENABLE_OVERFLOW_CHECK

4.9.5.23 template<typename NumberType , typename T , template< typename, bool, template< class, typename, bool > class, template< typename > class > class GCD, template< class, typename, bool > class CHKOP> bool operator== (const NumberType & *n,* const Rational< T, GCD, CHKOP > & *o*) [related]

Template Parameters

NumberType	the number type
T	the storage type
GCD	the GCD algorithm
CHKOP	checked operator

See also

ENABLE_OVERFLOW_CHECK

4.9.5.24 template<typename T , template< typename, bool, template< class, typename, bool > class, template< typename > class > class GCD, template< class, typename, bool > class CHKOP, typename NumberType > bool operator== (const Rational< T, GCD, CHKOP > & *o,* const NumberType & *n*) [related]

Template Parameters

T	the storage type
GCD	the GCD algorithm
NumberType	the number type
CHKOP	checked operator

See also

ENABLE_OVERFLOW_CHECK

4.9.5.25 template<typename NumberType , typename T , template< typename, bool, template< class, typename, bool > class, template< typename > class > class GCD, template< class, typename, bool > class CHKOP> bool operator> (const NumberType & *n,* const **Rational**< T, GCD, CHKOP > & *o*) [related]

Template Parameters

NumberType	the number type
T	the storage type
GCD	the GCD algorithm
CHKOP	checked operator

See also

ENABLE_OVERFLOW_CHECK

4.9.5.26 template<typename T , template< typename, bool, template< class, typename, bool > class, template< typename > class > class GCD, template< class, typename, bool > class CHKOP, typename NumberType > bool operator> (const **Rational**< T, GCD, CHKOP > & *o,* const NumberType & *n*) [related]

Template Parameters

T	the storage type
GCD	the GCD algorithm
NumberType	the number type
CHKOP	checked operator

See also

ENABLE_OVERFLOW_CHECK

4.9.5.27 template<typename NumberType , typename T , template< typename, bool, template< class, typename, bool > class, template< typename > class > class GCD, template< class, typename, bool > class CHKOP> bool operator>= (const NumberType & *n,* const **Rational**< T, GCD, CHKOP > & *o*) [related]

Template Parameters

NumberType	the number type
T	the storage type
GCD	the GCD algorithm

CHKOP	checked operator

See also

ENABLE_OVERFLOW_CHECK

4.9.5.28 template<typename T , template< typename, bool, template< class, typename, bool > class, template< typename > class > class GCD, template< class, typename, bool > class CHKOP, typename NumberType > bool operator>= (const Rational< T, GCD, CHKOP > & *o*, const NumberType & *n*) [related]

Template Parameters

T	the storage type
GCD	the GCD algorithm
NumberType	the number type
CHKOP	checked operator

See also

ENABLE_OVERFLOW_CHECK

4.9.5.29 template<typename T , template< typename, bool, template< class, typename, bool > class, template< typename > class > class GCD = GCD_euclid_fast, template< class, typename=T, bool=std::numeric_limits< T >::is_signed > class CHKOP = NO_OPERATOR_CHECK> std::istream& operator>> (std::istream & *i*, Rational< T, GCD, CHKOP > & *r*) [friend]

reads in an `expression` from a `std::istream` and assign it to `r`

See also

Rational(const char *expr)

Parameters

`in`	*i*	the stream to read from
`out`	*r*	the Rational to assign to

Returns

the stream `i`

4.9.6 Member Data Documentation

4.9.6.1 template<typename T , template< typename, bool, template< class, typename, bool > class, template< typename > class > class GCD = GCD_euclid_fast, template< class, typename=T, bool=std::numeric_limits< T >::is_signed > class CHKOP = NO_OPERATOR_CHECK> const Rational< T, GCD, CHKOP >::integer_type Commons::Math::Rational< T, GCD, CHKOP >::one_ = integer_type (1) [static]

represents *one* in the given Rational::integer_type

4.9.6.2 template<typename T , template< typename, bool, template< class, typename, bool > class, template< typename > class > class GCD = GCD_euclid_fast, template< class, typename=T, bool=std::numeric_limits< T >::is_signed > class CHKOP = NO_OPERATOR_CHECK> const Rational< T, GCD, CHKOP >::integer_type Commons::Math::Rational< T, GCD, CHKOP >::zero_ = integer_type() [static]

represents *zero* in the given Rational::integer_type

4.10 Commons::Math::RationalExpressionTraits< ExprT > Struct Template Reference

Traits struct for expression templates.

`#include <expr_rational.h>`

Public Types

- typedef ExprT expr_type

  the deduced expression type
- typedef expr_type literal_type

  the deduced literal type
- typedef expr_type variable_type

  the deduced variable type

4.10.1 Detailed Description

template<class ExprT>struct Commons::Math::RationalExpressionTraits< ExprT >

Traits struct for expression templates.

This traits struct can be used to get the types for variable declarations.

Examples:

- to create a literal `l`:

```
const Commons::Math::RationalExpressionTraits
  <Commons::Math::gmp_rational>::expr_type
    &l ( Commons::Math::mk_rat_lit (
      Commons::Math::gmp_rational ( 1, 1 ) ) );
```

- to create a variable `x` using the prototype `l`:

```
const Commons::Math::RationalExpressionTraits
  <Commons::Math::gmp_rational>::variable_type
    &x ( Commons::Math::mk_rat_proto_var ( l ) );
```

See also

Commons::Math::mk_rat_lit()
Commons::Math::mk_rat_proto_var()

4.10.2 Member Typedef Documentation

4.10.2.1 template<class ExprT > typedef ExprT Commons::Math::RationalExpressionTraits< ExprT >::expr_type

the deduced expression type

4.10.2.2 template<class ExprT > typedef expr_type Commons::Math::RationalExpressionTraits< ExprT >::literal_type

the deduced literal type

4.10.2.3 template<class ExprT > typedef expr_type Commons::Math::RationalExpressionTraits< ExprT >::variable_type

the deduced variable type

4.11 Commons::Math::TYPE_CONVERT< T > Struct Template Reference

Type coversion policy class.

`#include <rational.h>`

Public Member Functions

- TYPE_CONVERT (const T &v)

  Constructs a type converter.
- template<typename U >
  U convert () const

  converts the value to `U`

4.11.1 Detailed Description

template<typename T>struct Commons::Math::TYPE_CONVERT< T >

Type coversion policy class.

Specialize this class to convert a type from `T` to `U`

Template Parameters

T	the type to convert from

4.11.2 Constructor & Destructor Documentation

4.11.2.1 template<typename T > Commons::Math::TYPE_CONVERT< T >::TYPE_CONVERT (const T & *v*) [inline], [explicit]

Constructs a type converter.

Parameters

in	*v*	the value to convert

4.11.3 Member Function Documentation

4.11.3.1 template<typename T > template<typename U > U Commons::Math::TYPE_CONVERT< T >::convert ( ) const [inline]

converts the value to `U`

Template Parameters

U	the type to convert to

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