

primesieve

8.0

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Chapter 1

Main Page

1.1 About

primesieve is a C/C++ library for quickly generating prime numbers. It generates the primes below 10^9 in just 0.2 seconds on a single core of an Intel Core i7-6700 3.4GHz CPU. primesieve can generate primes and prime k-tuplets up to 2^{64} . primesieve's memory requirement is about $\pi(\sqrt{n}) * 8$ bytes per thread, its run-time complexity is $O(n \log \log n)$ operations. The recommended way to get started is to first have a look at a few C or C++ example programs. The most common use cases are iterating over primes using `next_prime()` or `prev_prime()` and storing primes in a vector or an array.

For more information please visit <https://github.com/kimwalisch/primesieve>.

1.2 Installation

- **Install libprimesieve using package manager.**
- **Build libprimesieve from source.**

1.3 C API

- `primesieve.h` - primesieve C header.
- `primesieve_iterator` - Provides the `primesieve_next_prime()` and `primesieve_prev_prime()` functions.
- **C examples** - Example programs that show how to use libprimesieve.
- **C error handling** - How to detect and handle errors.
- **Link against libprimesieve.**

1.4 C++ API

- `primesieve.hpp` - primesieve C++ header.
- `primesieve::iterator` - Provides the `next_prime()` and `prev_prime()` methods.
- **C++ examples** - Example programs that show how to use libprimesieve.
- **C++ error handling** - How to detect and handle errors.
- **Link against libprimesieve.**

1.5 Performance tips

- [libprimesieve performance tips.](#)
- [libprimesieve multi-threading tips.](#)

Chapter 2

Namespace Index

2.1 Namespace List

Here is a list of all documented namespaces with brief descriptions:

primesieve	
Contains primesieve's C++ functions and classes	11

Chapter 3

Hierarchical Index

3.1 Class Hierarchy

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

primesieve::iterator	17
primesieve_iterator	21
std::runtime_error	
primesieve::primesieve_error	20

Chapter 4

Class Index

4.1 Class List

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

primesieve::iterator	Primesieve::iterator allows to easily iterate over primes both forwards and backwards	17
primesieve::primesieve_error	Primesieve throws a primesieve_error exception if an error occurs e.g	20
primesieve_iterator	C prime iterator, please refer to iterator.h for more information	21

Chapter 5

File Index

5.1 File List

Here is a list of all documented files with brief descriptions:

iterator.h	Primesieve_iterator allows to easily iterate over primes both forwards and backwards	23
iterator.hpp	Primesieve::iterator allows to easily iterate (forwards and backwards) over prime numbers . . .	26
primesieve.h	Primesieve C API	27
primesieve.hpp	Primesieve C++ API	33
primesieve_error.hpp	The primesieve_error class is used for all exceptions within primesieve	35

Chapter 6

Namespace Documentation

6.1 primesieve Namespace Reference

Contains primesieve's C++ functions and classes.

Classes

- struct [iterator](#)
[primesieve::iterator](#) allows to easily iterate over primes both forwards and backwards.
- class [primesieve_error](#)
primesieve throws a [primesieve_error](#) exception if an error occurs e.g.

Functions

- template<typename vect >
void [generate_primes](#) (uint64_t stop, vect *primes)
Store the primes \leq stop in the primes vector.
- template<typename vect >
void [generate_primes](#) (uint64_t start, uint64_t stop, vect *primes)
Store the primes within the interval [start, stop] in the primes vector.
- template<typename vect >
void [generate_n_primes](#) (uint64_t n, vect *primes)
Store the first n primes in the primes vector.
- template<typename vect >
void [generate_n_primes](#) (uint64_t n, uint64_t start, vect *primes)
Store the first n primes \geq start in the primes vector.
- uint64_t [nth_prime](#) (uint64_t n, uint64_t start=0)
Find the nth prime.
- uint64_t [count_primes](#) (uint64_t start, uint64_t stop)
Count the primes within the interval [start, stop].
- uint64_t [count_twins](#) (uint64_t start, uint64_t stop)
Count the twin primes within the interval [start, stop].
- uint64_t [count_triplets](#) (uint64_t start, uint64_t stop)
Count the prime triplets within the interval [start, stop].
- uint64_t [count_quadruplets](#) (uint64_t start, uint64_t stop)

- Count the prime quadruplets within the interval [start, stop].*
 - `uint64_t count_quintuplets (uint64_t start, uint64_t stop)`
Count the prime quintuplets within the interval [start, stop].
 - `uint64_t count_sextuplets (uint64_t start, uint64_t stop)`
Count the prime sextuplets within the interval [start, stop].
 - `void print_primes (uint64_t start, uint64_t stop)`
Print the primes within the interval [start, stop] to the standard output.
 - `void print_twins (uint64_t start, uint64_t stop)`
Print the twin primes within the interval [start, stop] to the standard output.
 - `void print_triplets (uint64_t start, uint64_t stop)`
Print the prime triplets within the interval [start, stop] to the standard output.
 - `void print_quadruplets (uint64_t start, uint64_t stop)`
Print the prime quadruplets within the interval [start, stop] to the standard output.
 - `void print_quintuplets (uint64_t start, uint64_t stop)`
Print the prime quintuplets within the interval [start, stop] to the standard output.
 - `void print_sextuplets (uint64_t start, uint64_t stop)`
Print the prime sextuplets within the interval [start, stop] to the standard output.
 - `uint64_t get_max_stop ()`
Returns the largest valid stop number for primesieve.
 - `int get_sieve_size ()`
Get the current set sieve size in KiB.
 - `int get_num_threads ()`
Get the current set number of threads.
 - `void set_sieve_size (int sieve_size)`
Set the sieve size in KiB (kibibyte).
 - `void set_num_threads (int num_threads)`
Set the number of threads for use in primesieve::count_() and primesieve::nth_prime().*
 - `std::string primesieve_version ()`
Get the primesieve version number, in the form "i.j".

6.1.1 Detailed Description

Contains primesieve's C++ functions and classes.

6.1.2 Function Documentation

6.1.2.1 count_primes()

```
uint64_t primesieve::count_primes (
    uint64_t start,
    uint64_t stop )
```

Count the primes within the interval [start, stop].

By default all CPU cores are used, use `primesieve::set_num_threads(int threads)` to change the number of threads.

Note that each call to `count_primes()` incurs an initialization overhead of $O(\sqrt{\text{stop}})$ even if the interval [start, stop] is tiny. Hence if you have written an algorithm that makes many calls to `count_primes()` it may be preferable to use a `primesieve::iterator` which needs to be initialized only once.

Examples

`count_primes.cpp`.

6.1.2.2 count_quadruplets()

```
uint64_t primesieve::count_quadruplets (
    uint64_t start,
    uint64_t stop )
```

Count the prime quadruplets within the interval [start, stop].

By default all CPU cores are used, use [primesieve::set_num_threads\(int threads\)](#) to change the number of threads.

6.1.2.3 count_quintuplets()

```
uint64_t primesieve::count_quintuplets (
    uint64_t start,
    uint64_t stop )
```

Count the prime quintuplets within the interval [start, stop].

By default all CPU cores are used, use [primesieve::set_num_threads\(int threads\)](#) to change the number of threads.

6.1.2.4 count_sextuplets()

```
uint64_t primesieve::count_sextuplets (
    uint64_t start,
    uint64_t stop )
```

Count the prime sextuplets within the interval [start, stop].

By default all CPU cores are used, use [primesieve::set_num_threads\(int threads\)](#) to change the number of threads.

6.1.2.5 count_triplets()

```
uint64_t primesieve::count_triplets (
    uint64_t start,
    uint64_t stop )
```

Count the prime triplets within the interval [start, stop].

By default all CPU cores are used, use [primesieve::set_num_threads\(int threads\)](#) to change the number of threads.

6.1.2.6 count_twins()

```
uint64_t primesieve::count_twins (
    uint64_t start,
    uint64_t stop )
```

Count the twin primes within the interval [start, stop].

By default all CPU cores are used, use [primesieve::set_num_threads\(int threads\)](#) to change the number of threads.

6.1.2.7 generate_n_primes() [1/2]

```
template<typename vect >
void primesieve::generate_n_primes (
    uint64_t n,
    uint64_t start,
    vect * primes ) [inline]
```

Store the first n primes \geq start in the primes vector.

@vect: std::vector or other vector type that is API compatible with std::vector.

6.1.2.8 generate_n_primes() [2/2]

```
template<typename vect >
void primesieve::generate_n_primes (
    uint64_t n,
    vect * primes ) [inline]
```

Store the first n primes in the primes vector.

@vect: std::vector or other vector type that is API compatible with std::vector.

Examples

[store_primes_in_vector.cpp](#).

6.1.2.9 generate_primes() [1/2]

```
template<typename vect >
void primesieve::generate_primes (
    uint64_t start,
    uint64_t stop,
    vect * primes ) [inline]
```

Store the primes within the interval [start, stop] in the primes vector.

@vect: std::vector or other vector type that is API compatible with std::vector.

6.1.2.10 generate_primes() [2/2]

```
template<typename vect >
void primesieve::generate_primes (
    uint64_t stop,
    vect * primes ) [inline]
```

Store the primes \leq stop in the primes vector.

@vect: std::vector or other vector type that is API compatible with std::vector.

Examples

[store_primes_in_vector.cpp](#).

6.1.2.11 get_max_stop()

```
uint64_t primesieve::get_max_stop ( )
```

Returns the largest valid stop number for primesieve.

Returns

$2^{64}-1$ (UINT64_MAX).

6.1.2.12 nth_prime()

```
uint64_t primesieve::nth_prime (
    int64_t n,
    uint64_t start = 0 )
```

Find the nth prime.

By default all CPU cores are used, use [primesieve::set_num_threads\(int threads\)](#) to change the number of threads.

Note that each call to `nth_prime(n, start)` incurs an initialization overhead of $O(\sqrt{\text{start}})$ even if `n` is tiny. Hence it is not a good idea to use [nth_prime\(\)](#) repeatedly in a loop to get the next (or previous) prime. For this use case it is better to use a [primesieve::iterator](#) which needs to be initialized only once.

Parameters

<i>n</i>	if <code>n = 0</code> finds the 1st prime \geq start, if <code>n > 0</code> finds the nth prime $>$ start, if <code>n < 0</code> finds the nth prime $<$ start (backwards).
----------	---

Examples

[nth_prime.cpp](#).

6.1.2.13 set_num_threads()

```
void primesieve::set_num_threads (
    int num_threads )
```

Set the number of threads for use in `primesieve::count_*`() and [primesieve::nth_prime\(\)](#).

By default all CPU cores are used.

6.1.2.14 `set_sieve_size()`

```
void primesieve::set_sieve_size (
    int sieve_size )
```

Set the sieve size in KiB (kibibyte).

The best sieving performance is achieved with a sieve size of your CPU's L1 or L2 cache size (per core).

Precondition

`sieve_size >= 16 && <= 8192.`

Chapter 7

Class Documentation

7.1 primesieve::iterator Struct Reference

`primesieve::iterator` allows to easily iterate over primes both forwards and backwards.

```
#include <iterator.hpp>
```

Public Member Functions

- `iterator ()` noexcept
Create a new iterator object.
- `iterator (uint64_t start, uint64_t stop_hint=std::numeric_limits< uint64_t >::max())` noexcept
Create a new iterator object.
- `void skipto (uint64_t start, uint64_t stop_hint=std::numeric_limits< uint64_t >::max())` noexcept
Reset the primesieve iterator to start.
- `iterator (const iterator &)=delete`
primesieve::iterator objects cannot be copied.
- `iterator & operator= (const iterator &)=delete`
- `iterator (iterator &&) noexcept`
primesieve::iterator objects support move semantics.
- `iterator & operator= (iterator &&) noexcept`
- `~iterator ()`
Frees all memory.
- `void clear ()` noexcept
Frees most memory, but keeps some smaller data structures (e.g.
- `void generate_next_primes ()`
- `void generate_prev_primes ()`
- `uint64_t next_prime ()`
Get the next prime.
- `uint64_t prev_prime ()`
Get the previous prime.

Public Attributes

- `std::size_t i_`
- `std::size_t size_`
- `uint64_t start_`
- `uint64_t stop_hint_`
- `uint64_t * primes_`
- `void * memory_`

7.1.1 Detailed Description

[primesieve::iterator](#) allows to easily iterate over primes both forwards and backwards.

Generating the first prime has a complexity of $O(r \log \log r)$ operations with $r = n^{0.5}$, after that any additional prime is generated in amortized $O(\log n \log \log n)$ operations. The memory usage is $\text{PrimePi}(n^{0.5}) * 8$ bytes.

Examples

[prev_prime.cpp](#), and [primesieve_iterator.cpp](#).

7.1.2 Constructor & Destructor Documentation

7.1.2.1 iterator() [1/2]

```
primesieve::iterator::iterator ( ) [noexcept]
```

Create a new iterator object.

Generate primes > 0 . The start number is default initialized to 0 and the stop_hint is default initialized `UINT64_MAX`.

7.1.2.2 iterator() [2/2]

```
primesieve::iterator::iterator (
    uint64_t start,
    uint64_t stop_hint = std::numeric_limits< uint64_t >::max() ) [noexcept]
```

Create a new iterator object.

Parameters

<i>start</i>	Generate primes $> start$ (or $< start$).
<i>stop_hint</i>	Stop number optimization hint, gives significant speed up if few primes are generated. E.g. if you want to generate the primes below 1000 use <code>stop_hint = 1000</code> .

7.1.3 Member Function Documentation

7.1.3.1 clear()

```
void primesieve::iterator::clear ( ) [noexcept]
```

Frees most memory, but keeps some smaller data structures (e.g.

the PreSieve object) that are useful if the [primesieve::iterator](#) is reused. The remaining memory uses at most 200 kilobytes.

7.1.3.2 next_prime()

```
uint64_t primesieve::iterator::next_prime ( ) [inline]
```

Get the next prime.

Returns UINT64_MAX if next prime $> 2^{64}$.

Examples

[primesieve_iterator.cpp](#).

7.1.3.3 prev_prime()

```
uint64_t primesieve::iterator::prev_prime ( ) [inline]
```

Get the previous prime.

`prev_prime(n)` returns 0 for $n \leq 2$. Note that [next_prime\(\)](#) runs up to 2x faster than [prev_prime\(\)](#). Hence if the same algorithm can be written using either [prev_prime\(\)](#) or [next_prime\(\)](#) it is preferable to use [next_prime\(\)](#).

Examples

[prev_prime.cpp](#).

7.1.3.4 skipto()

```
void primesieve::iterator::skipto (
    uint64_t start,
    uint64_t stop_hint = std::numeric_limits< uint64_t >::max() ) [noexcept]
```

Reset the primesieve iterator to start.

Parameters

<i>start</i>	Generate primes > start (or < start).
<i>stop_hint</i>	Stop number optimization hint, gives significant speed up if few primes are generated. E.g. if you want to generate the primes below 1000 use stop_hint = 1000.

Examples

[prev_prime.cpp](#).

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

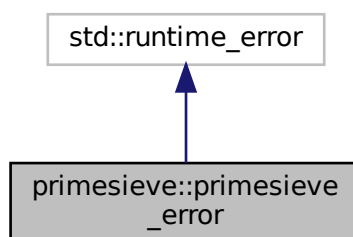
- [iterator.hpp](#)

7.2 primesieve::primesieve_error Class Reference

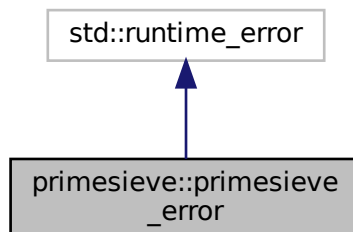
primesieve throws a [primesieve_error](#) exception if an error occurs e.g.

```
#include <primesieve_error.hpp>
```

Inheritance diagram for primesieve::primesieve_error:



Collaboration diagram for primesieve::primesieve_error:



Public Member Functions

- `primesieve_error` (const std::string &msg)

7.2.1 Detailed Description

primesieve throws a [primesieve_error](#) exception if an error occurs e.g.

prime > 2⁶⁴.

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

- [primesieve_error.hpp](#)

7.3 primesieve_iterator Struct Reference

C prime iterator, please refer to [iterator.h](#) for more information.

```
#include <iterator.h>
```

Public Attributes

- `size_t i`
- `size_t size`
- `uint64_t start`
- `uint64_t stop_hint`
- `uint64_t * primes`
- `void * memory`
- `int is_error`

7.3.1 Detailed Description

C prime iterator, please refer to [iterator.h](#) for more information.

Examples

[prev_prime.c](#), and [primesieve_iterator.c](#).

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

- [iterator.h](#)

Chapter 8

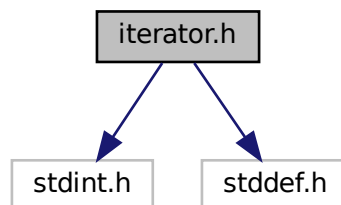
File Documentation

8.1 iterator.h File Reference

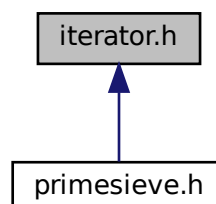
[primesieve_iterator](#) allows to easily iterate over primes both forwards and backwards.

```
#include <stdint.h>
#include <stddef.h>
```

Include dependency graph for iterator.h:



This graph shows which files directly or indirectly include this file:



Classes

- struct [primesieve_iterator](#)
C prime iterator, please refer to [iterator.h](#) for more information.

Macros

- #define [IF_UNLIKELY_PRIMESIEVE](#)(x) if (x)

Functions

- void [primesieve_init](#) ([primesieve_iterator](#) *it)
Initialize the primesieve iterator before first using it.
- void [primesieve_free_iterator](#) ([primesieve_iterator](#) *it)
Free all memory.
- void [primesieve_clear](#) ([primesieve_iterator](#) *it)
Frees most memory, but keeps some smaller data structures (e.g.
- void [primesieve_skipto](#) ([primesieve_iterator](#) *it, uint64_t start, uint64_t stop_hint)
Reset the primesieve iterator to start.
- static uint64_t [primesieve_next_prime](#) ([primesieve_iterator](#) *it)
Get the next prime.
- static uint64_t [primesieve_prev_prime](#) ([primesieve_iterator](#) *it)
Get the previous prime.

8.1.1 Detailed Description

[primesieve_iterator](#) allows to easily iterate over primes both forwards and backwards.

Generating the first prime has a complexity of $O(r \log \log r)$ operations with $r = n^{0.5}$, after that any additional prime is generated in amortized $O(\log n \log \log n)$ operations. The memory usage is about $\text{PrimePi}(n^{0.5}) * 8$ bytes.

The [primesieve_iterator.c](#) example shows how to use [primesieve_iterator](#). If any error occurs [primesieve_next_prime\(\)](#) and [primesieve_prev_prime\(\)](#) return `PRIMESIEVE_ERROR`. Furthermore `primesieve_iterator.is_error` is initialized to 0 and set to 1 if any error occurs.

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8.1.2 Function Documentation

8.1.2.1 [primesieve_clear\(\)](#)

```
void primesieve_clear (
    primesieve\_iterator * it )
```

Frees most memory, but keeps some smaller data structures (e.g.

the PreSieve object) that are useful if the [primesieve_iterator](#) is reused. The remaining memory uses at most 200 kilobytes.

8.1.2.2 primesieve_next_prime()

```
static uint64_t primesieve_next_prime (
    primesieve_iterator * it ) [inline], [static]
```

Get the next prime.

Returns UINT64_MAX if next prime $> 2^{64}$.

Examples

[primesieve_iterator.c](#).

8.1.2.3 primesieve_prev_prime()

```
static uint64_t primesieve_prev_prime (
    primesieve_iterator * it ) [inline], [static]
```

Get the previous prime.

`primesieve_prev_prime(n)` returns 0 for $n \leq 2$. Note that [primesieve_next_prime\(\)](#) runs up to 2x faster than [primesieve_prev_prime\(\)](#). Hence if the same algorithm can be written using either [primesieve_prev_prime\(\)](#) or [primesieve_next_prime\(\)](#) it is preferable to use [primesieve_next_prime\(\)](#).

Examples

[prev_prime.c](#).

8.1.2.4 primesieve_skipto()

```
void primesieve_skipto (
    primesieve_iterator * it,
    uint64_t start,
    uint64_t stop_hint )
```

Reset the primesieve iterator to start.

Parameters

<i>start</i>	Generate primes $>$ start (or $<$ start).
<i>stop_hint</i>	Stop number optimization hint. E.g. if you want to generate the primes below 1000 use <code>stop_hint = 1000</code> , if you don't know use <code>UINT64_MAX</code> .

Examples

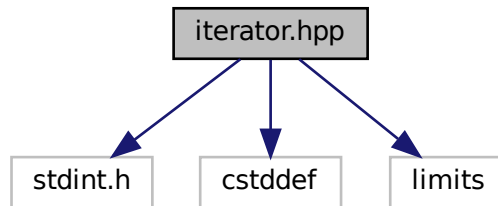
[prev_prime.c](#), and [primesieve_iterator.c](#).

8.2 iterator.hpp File Reference

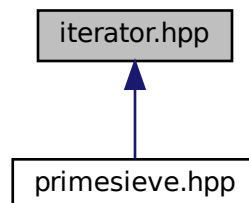
[primesieve::iterator](#) allows to easily iterate (forwards and backwards) over prime numbers.

```
#include <stdint.h>
#include <cstdint>
#include <limits>
```

Include dependency graph for iterator.hpp:



This graph shows which files directly or indirectly include this file:



Classes

- struct [primesieve::iterator](#)
[primesieve::iterator](#) allows to easily iterate over primes both forwards and backwards.

Namespaces

- [primesieve](#)
Contains primesieve's C++ functions and classes.

Macros

- `#define IF_UNLIKELY_PRIMESIEVE(x) if (x)`

8.2.1 Detailed Description

`primesieve::iterator` allows to easily iterate (forwards and backwards) over prime numbers.

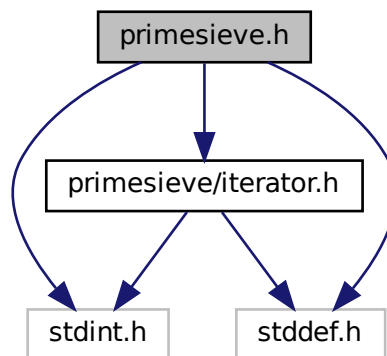
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8.3 primesieve.h File Reference

primesieve C API.

```
#include <primesieve/iterator.h>
#include <stdint.h>
#include <stddef.h>
Include dependency graph for primesieve.h:
```



Macros

- `#define PRIMESIEVE_VERSION "8.0"`
- `#define PRIMESIEVE_VERSION_MAJOR 8`
- `#define PRIMESIEVE_VERSION_MINOR 0`
- `#define PRIMESIEVE_ERROR ((uint64_t) ~((uint64_t) 0))`
primesieve functions return PRIMESIEVE_ERROR (UINT64_MAX) if any error occurs.

Enumerations

- `enum {`
`SHORT_PRIMES, USHORT_PRIMES, INT_PRIMES, UINT_PRIMES,`
`LONG_PRIMES, ULONG_PRIMES, LONGLONG_PRIMES, ULLONG_PRIMES,`
`INT16_PRIMES, UINT16_PRIMES, INT32_PRIMES, UINT32_PRIMES,`
`INT64_PRIMES, UINT64_PRIMES }`

Functions

- void * [primesieve_generate_primes](#) (uint64_t start, uint64_t stop, size_t *size, int type)
Get an array with the primes inside the interval [start, stop].
- void * [primesieve_generate_n_primes](#) (uint64_t n, uint64_t start, int type)
Get an array with the first n primes \geq start.
- uint64_t [primesieve_nth_prime](#) (uint64_t n, uint64_t start)
Find the nth prime.
- uint64_t [primesieve_count_primes](#) (uint64_t start, uint64_t stop)
Count the primes within the interval [start, stop].
- uint64_t [primesieve_count_twins](#) (uint64_t start, uint64_t stop)
Count the twin primes within the interval [start, stop].
- uint64_t [primesieve_count_triplets](#) (uint64_t start, uint64_t stop)
Count the prime triplets within the interval [start, stop].
- uint64_t [primesieve_count_quadruplets](#) (uint64_t start, uint64_t stop)
Count the prime quadruplets within the interval [start, stop].
- uint64_t [primesieve_count_quintuplets](#) (uint64_t start, uint64_t stop)
Count the prime quintuplets within the interval [start, stop].
- uint64_t [primesieve_count_sextuplets](#) (uint64_t start, uint64_t stop)
Count the prime sextuplets within the interval [start, stop].
- void [primesieve_print_primes](#) (uint64_t start, uint64_t stop)
Print the primes within the interval [start, stop] to the standard output.
- void [primesieve_print_twins](#) (uint64_t start, uint64_t stop)
Print the twin primes within the interval [start, stop] to the standard output.
- void [primesieve_print_triplets](#) (uint64_t start, uint64_t stop)
Print the prime triplets within the interval [start, stop] to the standard output.
- void [primesieve_print_quadruplets](#) (uint64_t start, uint64_t stop)
Print the prime quadruplets within the interval [start, stop] to the standard output.
- void [primesieve_print_quintuplets](#) (uint64_t start, uint64_t stop)
Print the prime quintuplets within the interval [start, stop] to the standard output.
- void [primesieve_print_sextuplets](#) (uint64_t start, uint64_t stop)
Print the prime sextuplets within the interval [start, stop] to the standard output.
- uint64_t [primesieve_get_max_stop](#) ()
Returns the largest valid stop number for primesieve.
- int [primesieve_get_sieve_size](#) ()
Get the current set sieve size in KiB.
- int [primesieve_get_num_threads](#) ()
Get the current set number of threads.
- void [primesieve_set_sieve_size](#) (int sieve_size)
Set the sieve size in KiB (kibibyte).
- void [primesieve_set_num_threads](#) (int num_threads)
Set the number of threads for use in [primesieve_count_\(\)](#) and [primesieve_nth_prime\(\)](#).*
- void [primesieve_free](#) (void *primes)
Deallocate a primes array created using the [primesieve_generate_primes\(\)](#) or [primesieve_generate_n_primes\(\)](#) functions.
- const char * [primesieve_version](#) ()
Get the primesieve version number, in the form "i.j"

8.3.1 Detailed Description

primesieve C API.

primesieve is a library for quickly generating prime numbers. If an error occurs, primesieve functions with a `uint64_t` return type return `PRIMESIEVE_ERROR` and the corresponding error message is printed to the standard error stream. `libprimesieve` also sets the C `errno` variable to `EDOM` if an error occurs.

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8.3.2 Enumeration Type Documentation

8.3.2.1 anonymous enum

anonymous enum

Enumerator

SHORT_PRIMES	Generate primes of short type.
USHORT_PRIMES	Generate primes of unsigned short type.
INT_PRIMES	Generate primes of int type.
UINT_PRIMES	Generate primes of unsigned int type.
LONG_PRIMES	Generate primes of long type.
ULONG_PRIMES	Generate primes of unsigned long type.
LONGLONG_PRIMES	Generate primes of long long type.
ULONGLONG_PRIMES	Generate primes of unsigned long long type.
INT16_PRIMES	Generate primes of <code>int16_t</code> type.
UINT16_PRIMES	Generate primes of <code>uint16_t</code> type.
INT32_PRIMES	Generate primes of <code>int32_t</code> type.
UINT32_PRIMES	Generate primes of <code>uint32_t</code> type.
INT64_PRIMES	Generate primes of <code>int64_t</code> type.
UINT64_PRIMES	Generate primes of <code>uint64_t</code> type.

8.3.3 Function Documentation

8.3.3.1 primesieve_count_primes()

```
uint64_t primesieve_count_primes (
    uint64_t start,
    uint64_t stop )
```

Count the primes within the interval [start, stop].

By default all CPU cores are used, use [primesieve_set_num_threads\(int threads\)](#) to change the number of threads.

Note that each call to [primesieve_count_primes\(\)](#) incurs an initialization overhead of $O(\sqrt{\text{stop}})$ even if the interval [start, stop] is tiny. Hence if you have written an algorithm that makes many calls to [primesieve_count_primes\(\)](#) it may be preferable to use a [primesieve::iterator](#) which needs to be initialized only once.

Examples

[count_primes.c](#).

8.3.3.2 primesieve_count_quadruplets()

```
uint64_t primesieve_count_quadruplets (
    uint64_t start,
    uint64_t stop )
```

Count the prime quadruplets within the interval [start, stop].

By default all CPU cores are used, use [primesieve_set_num_threads\(int threads\)](#) to change the number of threads.

8.3.3.3 primesieve_count_quintuplets()

```
uint64_t primesieve_count_quintuplets (
    uint64_t start,
    uint64_t stop )
```

Count the prime quintuplets within the interval [start, stop].

By default all CPU cores are used, use [primesieve_set_num_threads\(int threads\)](#) to change the number of threads.

8.3.3.4 primesieve_count_sextuplets()

```
uint64_t primesieve_count_sextuplets (
    uint64_t start,
    uint64_t stop )
```

Count the prime sextuplets within the interval [start, stop].

By default all CPU cores are used, use [primesieve_set_num_threads\(int threads\)](#) to change the number of threads.

8.3.3.5 primesieve_count_triplets()

```
uint64_t primesieve_count_triplets (
    uint64_t start,
    uint64_t stop )
```

Count the prime triplets within the interval [start, stop].

By default all CPU cores are used, use [primesieve_set_num_threads\(int threads\)](#) to change the number of threads.

8.3.3.6 primesieve_count_twins()

```
uint64_t primesieve_count_twins (
    uint64_t start,
    uint64_t stop )
```

Count the twin primes within the interval [start, stop].

By default all CPU cores are used, use [primesieve_set_num_threads\(int threads\)](#) to change the number of threads.

8.3.3.7 primesieve_generate_n_primes()

```
void* primesieve_generate_n_primes (
    uint64_t n,
    uint64_t start,
    int type )
```

Get an array with the first n primes \geq start.

Parameters

<i>type</i>	The type of the primes to generate, e.g. INT_PRIMES.
-------------	--

Examples

[store_primes_in_array.c](#).

8.3.3.8 primesieve_generate_primes()

```
void* primesieve_generate_primes (
    uint64_t start,
    uint64_t stop,
    size_t * size,
    int type )
```

Get an array with the primes inside the interval [start, stop].

Parameters

<i>size</i>	The size of the returned primes array.
<i>type</i>	The type of the primes to generate, e.g. INT_PRIMES.

Examples

[store_primes_in_array.c](#).

8.3.3.9 primesieve_get_max_stop()

```
uint64_t primesieve_get_max_stop ( )
```

Returns the largest valid stop number for primesieve.

Returns

$2^{64}-1$ (UINT64_MAX).

8.3.3.10 primesieve_nth_prime()

```
uint64_t primesieve_nth_prime (
    int64_t n,
    uint64_t start )
```

Find the nth prime.

By default all CPU cores are used, use [primesieve_set_num_threads\(int threads\)](#) to change the number of threads.

Note that each call to `primesieve_nth_prime(n, start)` incurs an initialization overhead of $O(\sqrt{\text{start}})$ even if `n` is tiny. Hence it is not a good idea to use [primesieve_nth_prime\(\)](#) repeatedly in a loop to get the next (or previous) prime. For this use case it is better to use a [primesieve::iterator](#) which needs to be initialized only once.

Parameters

<i>n</i>	if <code>n = 0</code> finds the 1st prime \geq start, if <code>n > 0</code> finds the nth prime $>$ start, if <code>n < 0</code> finds the nth prime $<$ start (backwards).
----------	---

Examples

[nth_prime.c](#).

8.3.3.11 primesieve_set_num_threads()

```
void primesieve_set_num_threads (
    int num_threads )
```

Set the number of threads for use in `primesieve_count_*`() and `primesieve_nth_prime()`.

By default all CPU cores are used.

8.3.3.12 primesieve_set_sieve_size()

```
void primesieve_set_sieve_size (
    int sieve_size )
```

Set the sieve size in KiB (kibibyte).

The best sieving performance is achieved with a sieve size of your CPU's L1 or L2 cache size (per core).

Precondition

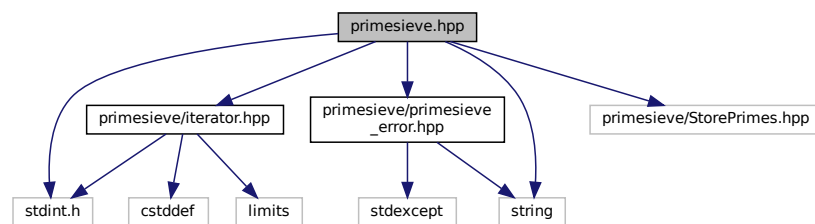
`sieve_size >= 16 && <= 8192.`

8.4 primesieve.hpp File Reference

primesieve C++ API.

```
#include <primesieve/iterator.hpp>
#include <primesieve/primesieve_error.hpp>
#include <primesieve/StorePrimes.hpp>
#include <stdint.h>
#include <string>
```

Include dependency graph for `primesieve.hpp`:



Namespaces

- `primesieve`

Contains primesieve's C++ functions and classes.

Macros

- `#define PRIMESIEVE_VERSION "8.0"`
- `#define PRIMESIEVE_VERSION_MAJOR 8`
- `#define PRIMESIEVE_VERSION_MINOR 0`

Functions

- `template<typename vect >`
`void primesieve::generate_primes (uint64_t stop, vect *primes)`
Store the primes \leq stop in the primes vector.
- `template<typename vect >`
`void primesieve::generate_primes (uint64_t start, uint64_t stop, vect *primes)`
Store the primes within the interval [start, stop] in the primes vector.
- `template<typename vect >`
`void primesieve::generate_n_primes (uint64_t n, vect *primes)`
Store the first n primes in the primes vector.
- `template<typename vect >`
`void primesieve::generate_n_primes (uint64_t n, uint64_t start, vect *primes)`
Store the first n primes \geq start in the primes vector.
- `uint64_t primesieve::nth_prime (uint64_t n, uint64_t start=0)`
Find the nth prime.
- `uint64_t primesieve::count_primes (uint64_t start, uint64_t stop)`
Count the primes within the interval [start, stop].
- `uint64_t primesieve::count_twins (uint64_t start, uint64_t stop)`
Count the twin primes within the interval [start, stop].
- `uint64_t primesieve::count_triplets (uint64_t start, uint64_t stop)`
Count the prime triplets within the interval [start, stop].
- `uint64_t primesieve::count_quadruplets (uint64_t start, uint64_t stop)`
Count the prime quadruplets within the interval [start, stop].
- `uint64_t primesieve::count_quintuplets (uint64_t start, uint64_t stop)`
Count the prime quintuplets within the interval [start, stop].
- `uint64_t primesieve::count_sextuplets (uint64_t start, uint64_t stop)`
Count the prime sextuplets within the interval [start, stop].
- `void primesieve::print_primes (uint64_t start, uint64_t stop)`
Print the primes within the interval [start, stop] to the standard output.
- `void primesieve::print_twins (uint64_t start, uint64_t stop)`
Print the twin primes within the interval [start, stop] to the standard output.
- `void primesieve::print_triplets (uint64_t start, uint64_t stop)`
Print the prime triplets within the interval [start, stop] to the standard output.
- `void primesieve::print_quadruplets (uint64_t start, uint64_t stop)`
Print the prime quadruplets within the interval [start, stop] to the standard output.
- `void primesieve::print_quintuplets (uint64_t start, uint64_t stop)`
Print the prime quintuplets within the interval [start, stop] to the standard output.
- `void primesieve::print_sextuplets (uint64_t start, uint64_t stop)`
Print the prime sextuplets within the interval [start, stop] to the standard output.
- `uint64_t primesieve::get_max_stop ()`
Returns the largest valid stop number for primesieve.
- `int primesieve::get_sieve_size ()`
Get the current set sieve size in KiB.
- `int primesieve::get_num_threads ()`

- *Get the current set number of threads.*
void `primesieve::set_sieve_size` (int sieve_size)
- *Set the sieve size in KiB (kibibyte).*
void `primesieve::set_num_threads` (int num_threads)
- *Set the number of threads for use in `primesieve::count_*`() and `primesieve::nth_prime`().*
std::string `primesieve::primesieve_version` ()
- *Get the primesieve version number, in the form "i.j".*

8.4.1 Detailed Description

primesieve C++ API.

primesieve is a library for fast prime number generation, in case an error occurs a `primesieve::primesieve_error` exception (derived from `std::runtime_error`) is thrown.

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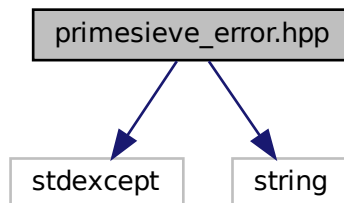
8.5 primesieve_error.hpp File Reference

The `primesieve_error` class is used for all exceptions within primesieve.

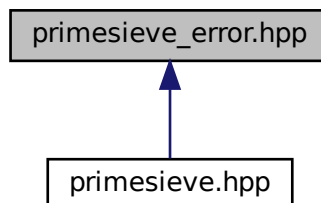
```
#include <stdexcept>
```

```
#include <string>
```

Include dependency graph for `primesieve_error.hpp`:



This graph shows which files directly or indirectly include this file:



Classes

- class [primesieve::primesieve_error](#)
primesieve throws a [primesieve_error](#) exception if an error occurs e.g.

Namespaces

- [primesieve](#)
Contains primesieve's C++ functions and classes.

8.5.1 Detailed Description

The `primesieve_error` class is used for all exceptions within `primesieve`.

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Chapter 9

Example Documentation

9.1 count_primes.cpp

This example shows how to count primes.

```
#include <primesieve.hpp>
#include <stdint.h>
#include <iostream>
int main()
{
    uint64_t count = primesieve::count_primes(0, 1000);
    std::cout << "Primes below 1000 = " << count << std::endl;
    return 0;
}
```

9.2 primesieve_iterator.cpp

Iterate over primes using `primesieve::iterator`.

```
#include <primesieve.hpp>
#include <cstdlib>
#include <iostream>
int main(int argc, char** argv)
{
    uint64_t limit = 10000000000ull;
    if (argc > 1)
        limit = std::atol(argv[1]);
    primesieve::iterator it(0, limit);
    uint64_t prime = it.next_prime();
    uint64_t sum = 0;
    // iterate over the primes below 10^9
    for (; prime <= limit; prime = it.next_prime())
        sum += prime;
    std::cout << "Sum of primes <= " << limit << " = " << sum << std::endl;
    // Note that since sum is a 64-bit variable the result
    // will be incorrect (due to integer overflow) if
    // limit > 10^10. However we do allow limits > 10^10
    // since this is useful for benchmarking.
    if (limit > 10000000000ull)
        std::cerr << "Warning: sum is likely incorrect due to 64-bit integer overflow!" << std::endl;
    return 0;
}
```

9.3 nth_prime.cpp

Find the *nth* prime.

```
#include <primesieve.hpp>
#include <stdint.h>
#include <iostream>
```

```
#include <cstdlib>
int main(int, char** argv)
{
    uint64_t n = 1000;
    if (argv[1])
        n = std::atol(argv[1]);
    uint64_t nth_prime = primesieve::nth_prime(n);
    std::cout << n << "th prime = " << nth_prime << std::endl;
    return 0;
}
```

9.4 prev_prime.cpp

Iterate backwards over primes using `primesieve::iterator`.

```
#include <primesieve.hpp>
#include <cstdlib>
#include <iostream>
int main(int argc, char** argv)
{
    uint64_t limit = 10000000000ull;
    if (argc > 1)
        limit = std::atol(argv[1]);
    primesieve::iterator it;
    it.skipto(limit);
    uint64_t prime = it.prev_prime();
    uint64_t sum = 0;
    // iterate over the primes below 10^9
    for (; prime > 0; prime = it.prev_prime())
        sum += prime;
    std::cout << "Sum of primes < " << limit << " = " << sum << std::endl;
    // Note that since sum is a 64-bit variable the result
    // will be incorrect (due to integer overflow) if
    // limit > 10^10. However we do allow limits > 10^10
    // since this is useful for benchmarking.
    if (limit > 10000000000ull)
        std::cerr << "Warning: sum is likely incorrect due to 64-bit integer overflow!" << std::endl;
    return 0;
}
```

9.5 store_primes_in_vector.cpp

Store primes in a `std::vector` using `primesieve`.

```
#include <primesieve.hpp>
#include <vector>
int main()
{
    std::vector<int> primes;
    // Store primes <= 1000
    primesieve::generate_primes(1000, &primes);
    primes.clear();
    // Store primes inside [1000, 2000]
    primesieve::generate_primes(1000, 2000, &primes);
    primes.clear();
    // Store first 1000 primes
    primesieve::generate_n_primes(1000, &primes);
    primes.clear();
    // Store first 10 primes >= 1000
    primesieve::generate_n_primes(10, 1000, &primes);
    return 0;
}
```

9.6 count_primes.c

C program that shows how to count primes.

```
#include <primesieve.h>
#include <inttypes.h>
#include <stdio.h>
int main()
{
    uint64_t count = primesieve_count_primes(0, 1000);
    printf("Primes below 1000 = %" PRIu64 "\n", count);
    return 0;
}
```

9.7 prev_prime.c

Iterate backwards over primes using `primesieve_iterator`. Note that `primesieve_next_prime()` runs up to 2x faster and uses only half as much memory as `primesieve_prev_prime()`. Hence if it is possible to write the same algorithm using either `primesieve_prev_prime()` or `primesieve_next_prime()` then it is preferable to use `primesieve_next_prime()`.

```
#include <primesieve.h>
#include <inttypes.h>
#include <stdlib.h>
#include <stdio.h>
int main(int argc, char** argv)
{
    uint64_t limit = 10000000000ull;
    if (argc > 1)
        limit = atol(argv[1]);
    primesieve_iterator it;
    primesieve_init(&it);
    /* primesieve_skipto(&it, start_number, stop_hint) */
    primesieve_skipto(&it, limit, 0);
    uint64_t prime;
    uint64_t sum = 0;
    /* iterate over primes from limit to 0 */
    while ((prime = primesieve_prev_prime(&it)) > 0)
        sum += prime;
    primesieve_free_iterator(&it);
    printf("Sum of the primes: %" PRIu64 "\n", sum);
    /* Note that since sum is a 64-bit variable the result
     * will be incorrect (due to integer overflow) if
     * limit > 10^10. However we do allow limits > 10^10
     * since this is useful for benchmarking. */
    if (limit > 10000000000ull)
        printf("Warning: sum is likely incorrect due to 64-bit integer overflow!");
    return 0;
}
```

9.8 primesieve_iterator.c

Iterate over primes using C `primesieve_iterator`.

```
#include <primesieve.h>
#include <inttypes.h>
#include <stdio.h>
#include <stdlib.h>
int main(int argc, char** argv)
{
    uint64_t limit = 10000000000ull;
    if (argc > 1)
        limit = atol(argv[1]);
    primesieve_iterator it;
    primesieve_init(&it);
    /* indicate exact bounds to improve performance */
    primesieve_skipto(&it, 0, limit);
    uint64_t sum = 0;
    uint64_t prime = 0;
    /* iterate over the primes below 10^9 */
    while ((prime = primesieve_next_prime(&it)) <= limit)
        sum += prime;
    printf("Sum of the primes <= %" PRIu64 " = %" PRIu64 "\n", limit, sum);
    primesieve_free_iterator(&it);
    return 0;
}
```

9.9 nth_prime.c

C program that finds the nth prime.

```
#include <primesieve.h>
#include <stdlib.h>
#include <inttypes.h>
#include <stdio.h>
int main(int argc, char** argv)
{
    uint64_t n = 1000;
    if (argc > 1 && argv[1])
        n = atol(argv[1]);
    uint64_t prime = primesieve_nth_prime(n, 0);
    printf("%" PRIu64 "th prime = %" PRIu64 "\n", n, prime);
    return 0;
}
```

9.10 store_primes_in_array.c

Store primes in a C array.

```
#include <primesieve.h>
#include <stdio.h>
int main()
{
    uint64_t start = 0;
    uint64_t stop = 1000;
    size_t i;
    size_t size;
    /* store the primes below 1000 */
    int* primes = (int*) primesieve_generate_primes(start, stop, &size, INT_PRIMES);
    for (i = 0; i < size; i++)
        printf("%i\n", primes[i]);
    primesieve_free(primes);
    uint64_t n = 1000;
    /* store the first 1000 primes */
    primes = (int*) primesieve_generate_n_primes(n, start, INT_PRIMES);
    for (i = 0; i < n; i++)
        printf("%i\n", primes[i]);
    primesieve_free(primes);
    return 0;
}
```

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- count_quadruplets
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