

## NASDAQ ITCH50 Book Constructor

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# Chapter 1

## Class Index

### 1.1 Class List

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

<a href="#">BookConstructor</a>	5
<a href="#">Message</a>	8
<a href="#">Order</a>	9
<a href="#">OrderBook</a>	10
<a href="#">OrderPool</a>	11
<a href="#">Reader</a>	13
<a href="#">Writer</a>	15



## Chapter 2

# File Index

### 2.1 File List

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

include/ <b>BookConstructor.hpp</b>	??
include/ <b>Message.hpp</b>	??
include/ <b>Order.hpp</b>	??
include/ <b>OrderBook.hpp</b>	??
include/ <b>OrderPool.hpp</b>	??
include/ <b>Reader.hpp</b>	??
include/ <b>utility.hpp</b>	??
include/ <b>Writer.hpp</b>	??
src/ <a href="#">utility.cpp</a>	<a href="#">17</a>





## Chapter 3

# Class Documentation

### 3.1 BookConstructor Class Reference

#### Public Member Functions

- [BookConstructor](#) (const std::string &inputMessageCSV, const std::string &outputMessageCSV, const std::string &outputBookCSV, const std::string &\_stock, const size\_t &\_levels)
- [~BookConstructor](#) ()
- void [start](#) (void)
- void [next](#) (void)
- bool [updateMessage](#) (void)
- void [updateBook](#) (void)
- void [updatePool](#) (void)
- void [WriteBookAndMessage](#) (void)

#### 3.1.1 Constructor & Destructor Documentation

##### 3.1.1.1 BookConstructor()

```
BookConstructor::BookConstructor (
    const std::string & inputMessageCSV,
    const std::string & outputMessageCSV,
    const std::string & outputBookCSV,
    const std::string & _stock,
    const size_t & _levels )
```

Class Initializer.

Principal class for the reconstruction of the order book. The constructor also writes the headers to the output files.

#### Parameters

in	<i>inputMessageCSV</i>	decompressed binary ITCH50 file to read from.
in	<i>_stock</i>	selected stock.
in	<i>_levels</i>	selected number of levels for order book.
out	<i>outputBookCSV,outputMessageCSV</i>	destination files to write order book and stream message.

### 3.1.1.2 `~BookConstructor()`

```
BookConstructor::~BookConstructor ( )
```

Class deconstructor.

For debug purposes print to std output orders still present at closure. There shouldn't be any.

## 3.1.2 Member Function Documentation

### 3.1.2.1 `next()`

```
void BookConstructor::next (
    void )
```

Process next message. Retain only message affecting the [OrderBook](#) (type A,P,D,R,E,C). Reads the message from the [Reader](#) interface then if necessary, complete message information retrieving information from [OrderPool](#), then updates the [OrderBook](#) and [OrderPool](#) according to the type of message received. At the end the [Writer](#) writes the book and message (enriched with all additional information) to the two output files.

### 3.1.2.2 `start()`

```
void BookConstructor::start (
    void )
```

Start Book reconstruction.

calls iteratively the next method until the [Reader](#) has completed the reading.

### 3.1.2.3 `updateBook()`

```
void BookConstructor::updateBook (
    void )
```

Update [OrderBook](#) with the current message.

Updates the [OrderBook](#) double map accordingly to the type of the message. A: Add the [Order](#) to the pool. If key in the map (price) is already there just add the size. Otherwise add the key with corresponding size. R: Replace existing order in the pool, hence cancel completely the existing size and create a new one.

#### 3.1.2.4 updateMessage()

```
bool BookConstructor::updateMessage (
    void )
```

Complete message information with missing field.

Once a message is readed by the reader this metod retrives missing informations from the order pool, this behaviour depends on the type of the message. Example : Execution messages miss Price -> retrieve order price from the OP through order ID.

A,P: all the informations are already present, stop. D: size and price information have to be retrived from the Pool. R: oldSize and oldPrice information have to be retrived from the Pool. E: size and price have to be retrived from the Pool. C: size and original price have to be retrived from the [Order](#) Pool.

#### 3.1.2.5 updatePool()

```
void BookConstructor::updatePool (
    void )
```

Update [OrderPool](#) with the current [Message](#).

Using the message attribute in the [BookConstructor](#) class updates the pool.

- A: Add order to [OrderPool](#).
- R: Delete order and add new one.
- D: Delete (partially or totally) order.
- E: Execute (partially or totally) order.
- C: Execute order at different price.
- P: Execute hidden order. Does not affect the book.

#### 3.1.2.6 WriteBookAndMessage()

```
void BookConstructor::WriteBookAndMessage (
    void )
```

Write in output [OrderBook](#) state and message stream through [Writer](#) class.

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

- include/BookConstructor.hpp
- src/BookConstructor.cpp

## 3.2 Message Class Reference

### Public Member Functions

- **Message** (const std::string &type, const id\_type &id, const time\_type &timestamp)
- void **setType** (const std::string &)
- void **setId** (const id\_type &)
- void **setTimeStamp** (const time\_type &)
- void **setSide** (const side\_type &)
- void **setPrice** (const price\_type &)
- void **setRemSize** (const size\_type &)
- void **setCancSize** (const size\_type &)
- void **setExecSize** (const size\_type &)
- void **setOldId** (const id\_type &id)
- void **setOldPrice** (const price\_type &)
- void **setOldSize** (const size\_type &)
- std::string **getType** (void) const
- id\_type **getId** (void) const
- time\_type **getTimeStamp** (void) const
- side\_type **getSide** (void) const
- price\_type **getPrice** (void) const
- size\_type **getRemSize** (void) const
- size\_type **getCancSize** (void) const
- size\_type **getExecSize** (void) const
- id\_type **getOldId** (void) const
- price\_type **getOldPrice** (void) const
- size\_type **getOldSize** (void) const
- bool **isEmpty** (void) const
- std::string **getString** (void) const
- void **print** (void) const

### 3.2.1 Member Function Documentation

#### 3.2.1.1 getString()

```
std::string Message::getString (  
    void ) const
```

Get string representation for writing into the csv

#### Returns

string representation of message. If field is not being setted is just an empty char separated by commas.

## 3.2.1.2 setType()

```
void Message::setType (
    const std::string & _type )
```

Setter for the messegae. Transforms the Nasdaq type defintions in ours.

- NASDAQ --> Custom
- A,F --> (A)dd
- D,X --> (D)elete
- U --> (R)eplace
- E --> (E)xecution
- P --> P, hidden execution
- C --> C, execution at different price

## Parameters

in	_type	type string: according to the definition of NASDAQ
----	-------	--

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

- include/Message.hpp
- src/Message.cpp

## 3.3 Order Class Reference

## Public Member Functions

- **Order** (id\_type \_id, side\_type \_side, size\_type \_size, price\_type \_price)
- void [addSize](#) (size\_type size)
- id\_type **getId** (void) const
- side\_type **getSide** (void) const
- size\_type **getSize** (void) const
- price\_type **getPrice** (void) const
- void **print** (void) const
- bool [isEmpty](#) (void) const

## 3.3.1 Member Function Documentation

## 3.3.1.1 addSize()

```
void Order::addSize (
    size_type _size )
```

Add or subtract size to the order.

**Parameters**

<code>in</code>	<code>_size</code>	: size to add or deduct (if size is negative) to the order
-----------------	--------------------	--

**3.3.1.2 isEmpty()**

```
bool Order::isEmpty (
    void ) const
```

Check wether the [Order](#) is unsetted or not.

**Returns**

bool, 1 is unsetted (Empty), 0 if setted.

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

- include/Order.hpp
- src/Order.cpp

**3.4 OrderBook Class Reference****Public Member Functions**

- std::string [getString](#) (const size\_t &) const
- void [modifySize](#) (price\_type, size\_type, side\_type)
- void [setTimeStamp](#) (const time\_type &)
- bool [checkBookConsistency](#) (void)

**3.4.1 Member Function Documentation****3.4.1.1 checkBookConsistency()**

```
bool OrderBook::checkBookConsistency (
    void )
```

Check if the biggest bid price is less than smallest ask

**Returns**

bool value of the check. 1 OK, 0 KO.

**3.4.1.2 getString()**

```
std::string OrderBook::getString (
    const size_t & level ) const
```

Make comma-separated string from information available in the [OrderBook](#) about the best bid/ask prices and corresponding sizes up to number of levels : "1.BidPrice, 1.BidSize,1.AskPrice,1.AskSize,...,level.BidPrice, level.BidSize,level.AskPrice,level.AskSize"

## Parameters

in	<i>level</i>	up to what level to write the price/size tuple.
----	--------------	---

## 3.4.1.3 modifySize()

```
void OrderBook::modifySize (
    price_type price,
    size_type size,
    side_type side )
```

Performs actions on the double map reosenting the [OrderBook](#)

## Parameters

in	<i>price</i>	modify map corresponding to price
in	<i>size</i>	add (or delete if size is negative) the size corresponding to price
in	<i>side</i>	0 for buy side and 1 for sell side.

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

- include/OrderBook.hpp
- src/OrderBook.cpp

## 3.5 OrderPool Class Reference

## Public Member Functions

- [Order](#) [searchOrderPool](#) (id\_type)
- void [addToOrderPool](#) (id\_type, bool, size\_type, price\_type)
- void [modifyOrder](#) (id\_type, size\_type)
- bool [isEmpty](#) (void) const
- void [printIds](#) (void) const

## 3.5.1 Member Function Documentation

## 3.5.1.1 addToOrderPool()

```
void OrderPool::addToOrderPool (
    id_type idOrder,
    bool side,
    size_type size,
    price_type price )
```

Initialize and add an [Order](#) to the [OrderPool](#)

**Parameters**

in	<i>idOrder</i>	id of the order to add
in	<i>side</i>	side of the order to add (0 for buy and 1 for sell)
in	<i>size</i>	size of the order to add to the pool
in	<i>price</i>	limit price of the order to add

**3.5.1.2 isEmpty()**

```
bool OrderPool::isEmpty (
    void ) const
```

Check wether the [OrderPool](#) map is empty

**Returns**

book, 1 if empty, 0 if not.

**3.5.1.3 modifyOrder()**

```
void OrderPool::modifyOrder (
    id_type idOrder,
    size_type size = 0 )
```

Delete size of an order in the [OrderPool](#).

If the remaining size if zero then order get deleted from the [OrderPool](#). size is always subtracted from the order.

**Parameters**

in	<i>idOrder</i>	id of the order to modify
in	<i>size</i>	size to subtract from the order.

**3.5.1.4 printIds()**

```
void OrderPool::printIds (
    void ) const
```

Prints id of all orders in the [OrderPool](#).

It's used at the end to check if the [OrderPool](#) is empty (should be).



## 3.5.1.5 searchOrderPool()

```
Order OrderPool::searchOrderPool (
    id_type idOrder )
```

Look for the [Order](#) specified by the id in the [OrderPool](#)

## Parameters

in	<i>idOrder</i>	: id relative to the order quaried
----	----------------	------------------------------------

## Returns

[Order](#) with id equals to idOrder.

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

- include/OrderPool.hpp
- src/OrderPool.cpp

## 3.6 Reader Class Reference

### Public Member Functions

- [Reader](#) (const std::string &fileName, const std::string &stock)
- [Reader](#) (const std::string &\_stock)
- bool **isValid** (void) const
- [Message](#) **createMessage** (void)
- bool **eof** (void)
- void **printProgress** (void)
- virtual void **readBytesIntoMessage** (const long &)
- virtual void **skipBytes** (const long &)
- void **setMessage** (const char \*)
- virtual char **getKey** (void)
- std::string **getFileName** (void) const
- std::string **getStock** (void) const

### 3.6.1 Constructor & Destructor Documentation

#### 3.6.1.1 Reader() [1/2]

```
Reader::Reader (
    const std::string & _fileName,
    const std::string & _stock )
```

Constructor for [Reader](#) class

If unable to open file to read print to standard error a [Message](#). If file has been opened correctly, write it to standard optput.

**Parameters**

in	<code>_fileName</code>	destination csv files to update.
in	<code>_stock</code>	For performace reasons, the <a href="#">Reader</a> class will discard directly all messages clearly related to other stocks

**3.6.1.2 Reader()** [2/2]

```
Reader::Reader (
    const std::string & _stock )
```

Alternative Constructor for [Reader](#) class

Constructor used in tests where we do not need a fileName.

**Parameters**

in	<code>_stock</code>	For performace reasons, the <a href="#">Reader</a> class will discard directly all messages clearly related to other stocks
----	---------------------	---

**3.6.2 Member Function Documentation****3.6.2.1 createMessage()**

```
Message Reader::createMessage (
    void )
```

Reads bytes from the stream and create a message

Main function of the class. Creates a [Message](#) object from the file stream and return a message to the [BookConstructor](#) class.

**Returns**

[Message](#) created from the read bytes.

**Warning**

Dead code is still present in the method. Might be used to parse the entire input ITCH50 file for debug purposes

### 3.6.2.2 printProgress()

```
void Reader::printProgress (
    void )
```

Progress updates

Writes to standard output a progress message with the number of messages analyzed up to now and average number of messages per second since the beginning.

### 3.6.2.3 readBytesIntoMessage()

```
void Reader::readBytesIntoMessage (
    const long & size ) [virtual]
```

Reads n bytes from the open file

Reads from the file into the message c-string attribute of the [Reader](#) class the specified number of bytes.

@params[in] size Number of bytes to read from the stream.

### 3.6.2.4 skipBytes()

```
void Reader::skipBytes (
    const long & size ) [virtual]
```

Skips n bytes from the stream

Discard from the file the specified number of bytes. Used mainly in the tests.

@params[in] size Number of bytes to discard from the stream.

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

- include/Reader.hpp
- src/Reader.cpp

## 3.7 Writer Class Reference

### Public Member Functions

- [Writer](#) (const std::string &fileName)
- void [writeLine](#) (const std::string &)
- std::string [getFileName](#) (void) const

### 3.7.1 Constructor & Destructor Documentation

#### 3.7.1.1 Writer()

```
Writer::Writer (
    const std::string & _fileName )
```

Constructor for [Writer](#) class

If unable to open file to read print to standard error a message. If file has been opened correctly, write it to standard output.

**Parameters**

in	<i>_fileName</i>	destination csv files to update.
----	------------------	----------------------------------

### 3.7.2 Member Function Documentation

#### 3.7.2.1 writeLine()

```
void Writer::writeLine (
    const std::string & stringToWrite )
```

Writes string to stream

It used to write the [Message](#) and the [OrderBook](#) strings to the outfiles.

**Parameters**

in	<i>stringToWrite</i>	string to write to the csv.
----	----------------------	-----------------------------

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

- include/Writer.hpp
- src/Writer.cpp

## Chapter 4

# File Documentation

### 4.1 src/utility.cpp File Reference

```
#include <utility.hpp>
```

#### Functions

- std::string [getFileName](#) (const std::string &path)
- uint16\_t [bswap\\_16](#) (uint16\_t value)
- uint32\_t [bswap\\_32](#) (uint32\_t value)
- uint64\_t [bswap\\_64](#) (uint64\_t value)
- uint16\_t [parse\\_uint16](#) (char \*a)
- uint32\_t [parse\\_uint32](#) (char \*a)
- uint64\_t [parse\\_uint64](#) (char \*a)
- uint64\_t [parse\\_ts](#) (char \*a)

#### Variables

- side\_type **SIDE\_DEFAULT** = 0
- id\_type **ID\_DEFAULT** = LLONG\_MAX
- price\_type **PRICE\_DEFAULT** = -1
- size\_type **SIZE\_DEFAULT** = -1

#### 4.1.1 Detailed Description

Delclaration of default values.

#### 4.1.2 Function Documentation

##### 4.1.2.1 bswap\_16()

```
uint16_t bswap_16 (  
    uint16_t value )
```

Utility function for swapping 16 bits from little endian to big endian format.

Since the bynary file is written in big endian and most Unix systems are little endian, we defined this utility functions to swap endianness. Uses binary masks to perform this operation.

**Parameters**

<i>in</i>	<i>value</i>	unsigned 16 type corresponding to the 16 bits in big endian to swap into little endian.
-----------	--------------	---

**Returns**

uint16\_t value of the swapped number

**Warning**

Assumes that the machine is little endian and hence the swapping is indeed necessary. Otherwise no swapping is needed. This checks is not performed.

**4.1.2.2 bswap\_32()**

```
uint32_t bswap_32 (  
    uint32_t value )
```

Utility function for swapping 32 bits from little endian to big endian format.

Since the bynary file is written in big endian and most Unix systems are little endian, we defined this utility functions to swap endianness. Uses binary masks to perform this operation.

**Parameters**

<i>in</i>	<i>value</i>	unsigned 16 type corresponding to the 32 bits in big endian to swap into little endian.
-----------	--------------	---

**Returns**

uint32\_t value of the swapped number

**Warning**

Assumes that the machine is little endian and hence the swapping is indeed necessary. Otherwise no swapping is needed. This checks is not performed.

**4.1.2.3 bswap\_64()**

```
uint64_t bswap_64 (  
    uint64_t value )
```

Utility function for swapping 64 bits from little endian to big endian format.

Since the bynary file is written in big endian and most Unix systems are little endian, we defined this utility functions to swap endianness. Uses binary masks to perform this operation.

**Parameters**

<i>in</i>	<i>value</i>	unsigned 64 type corresponding to the 64 bits in big endian to swap into little endian.
-----------	--------------	---

**Returns**

uint64\_t value of the swapped number

**Warning**

Assumes that the machine is little endian and hence the swapping is indeed necessary. Otherwise no swapping is needed. This checks is not performed.

**4.1.2.4 getFileName()**

```
std::string getFileName (  
    const std::string & path )
```

Simple utility function for get the file name from a path string

**Parameters**

<i>in</i>	<i>path</i>	string of the path of the file. Should also work for the separator "\\" (WINDOWS).
-----------	-------------	--

**Returns**

nameFile string of the file name.

**4.1.2.5 parse\_ts()**

```
uint64_t parse_ts (  
    char * a )
```

Utility function for parsing 48 bits data (for time stamp)

This reads from a char array pointer (C-style) 48 bits and return the swapped corresponding number

**Parameters**

<i>in</i>	<i>a</i>	char pointer to the 48 bits to parse
-----------	----------	--------------------------------------

**Returns**

uint64\_t number corresponding to the swapped data (48 bits) pointed by the char array

**Warning**

Assumes that the machine is little endian and hence the swapping is indeed necessary. Otherwise no swapping is needed. This checks is not performed.

**4.1.2.6 parse\_uint16()**

```
uint16_t parse_uint16 (  
    char * a )
```

Utility function for parsing 16 bits data.

This reads from a char array pointer (C-style) 16 bits and return the swapped corresponding number

**Parameters**

in	a	char pointer to the 16 bits to parse
----	---	--------------------------------------

**Returns**

uint16\_t number corresponding to the swapped data (16 bits) pointed by the char array

**Warning**

Assumes that the machine is little endian and hence the swapping is indeed necessary. Otherwise no swapping is needed. This checks is not performed.

**4.1.2.7 parse\_uint32()**

```
uint32_t parse_uint32 (  
    char * a )
```

Utility function for parsing 32 bits data.

This reads from a char array pointer (C-style) 32 bits and return the swapped corresponding number

**Parameters**

in	a	char pointer to the 32 bits to parse
----	---	--------------------------------------



**Returns**

uint32\_t number corresponding to the swapped data (32 bits) pointed by the char array

**Warning**

Assumes that the machine is little endian and hence the swapping is indeed necessary. Otherwise no swapping is needed. This checks is not performed.

**4.1.2.8 parse\_uint64()**

```
uint64_t parse_uint64 (  
    char * a )
```

Utility function for parsing 64 bits data.

This reads from a char array pointer (C-style) 64 bits and return the swapped corresponding number

**Parameters**

in	a	char pointer to the 64 bits to parse
----	---	--------------------------------------

**Returns**

uint64\_t number corresponding to the swapped data (64 bits) pointed by the char array

**Warning**

Assumes that the machine is little endian and hence the swapping is indeed necessary. Otherwise no swapping is needed. This checks is not performed.



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