tbg-Quant

algorithmic trading platform

April 2013

technical document

tbg-Quant v1.1beta4

www.thebonnotgang.com

I was cautioned to surrender, this I could not do;
I took my gun and vanished.
The Partisan - Leonard Cohen

Index

Introduction 5
Mission 6
KISS 7
Create, Test, Trade 7
Prerequisites 7
Functionalities 8
Download 9
Logical Data Model 10
System Use Case Scenario 11
Support & Help 12
Contacts 12
Platform Licence 13
Set-up 14
Download & Install tbg-Quant platform 14
Requirements 14
Downloads 14
Download and Execute 15
Running an example strategy 17
Running the Turn of the Month Strategy "ToM_Strategy" 17
Included examples and source code 19
Domain Model Components 20
The Model 21
Account 22
Account Implementations 22
Declaration 22
Portfolio 23
Broker 24
Broker Implementations 24
Declaration 24
Sending Orders 25
Cancel Order 25
Order 26

Declaration 27
MarketDataFeed 28
MarketDataFeed Implementations 28
Declaration 29
MarketDataEvent 30
TickEvent 30
CandleEvent 30
Declaration 30
Strategy 31
Declaration 31
TradingSystem 32
Declaration 32
How it all goes togheter 33
Store Service 36
Implementations 36
Report Service 37
Implementations 37
Declaration 37
Alarm Service 37
CEP Provider 38
Implementations 38
Declaration 39
Conclusion 40
In Action 41
Create a Strategy 42
Pre-Requisites 42
Add the libraries 42
Create your first Strategy 44
A Typical Strategy Structure 44
In Action: SimpleMovingAverage crossover 46
What we did 50
Test a Strategy 51
In Action: Assessing SimpleMovingAverage crossover strategy 51
Trade (execute) a Strategy 55

Appendix 56
Skeleton Strategy Code 57
Simple Moving Averages Crossover Strategy Code 58

Introduction

Advances in technology have greatly changed the financial industry, algorithmic trading is gaining popularity around the world. From the original order processing to the current cutting-edge technology, including trading systems, algorithmic trading has evolved into a billion dollar industry. It change the way financial assets are traded. Every step of the trading process, from order entry to trading venue to back office, is now highly automated, dramatically reducing the costs incurred by intermediaries. By reducing the frictions and costs of trading, technology has the potential to enable a more efficient risk sharing, facilitate hedging, improve liquidity, and make prices more efficient.

Nowadays all large broker-dealers offer a suite of algorithms to its institutional customers, helping them execute orders in a single stock, in pairs of stocks, or in baskets of stocks. Algorithms typically determine the timing, price, quantity and routing of orders, dynamically monitoring market conditions across different securities and trading venues, reducing market impact by optimally and sometimes randomly breaking large orders into smaller pieces, as well as closely tracking benchmarks, such as the volume-weighted average price (VWAP) over the execution interval. In the pursuit of a desired position, algorithms often use a mix of both active and passive strategies, employing both limit orders and marketable orders.

The tbg-Quant platform enables anyone with an interest in financial markets to access algorithmic trading technologies used by Hedge Funds.

After reading this document, you should have a complete understanding of the tbg-Quant platform. You will be able to create, test and execute your own automatic quantitative trading strategies on either historical or live market data.

Mission

Our mission is to empower traders to create a personal Quant Desk by providing a robust and simple to use algorithmic trading platform.

KISS

We strongly believe in the KISS principle (Keep It Simple Stupid) and we adopt it throughout our processes. We empower the trader to focus on strategy development, testing and final execution without losing valuable time learning the underneath software technology. The tbg-Quant platform consists of a robust yet simple software platform and IT infrastructure, empowering users to trade like a Hedge Fund.

Create, Test, Trade

- Create strategies using the build-in editor via web/HTML5 or by using your favorite IDE like Eclipse/Net Beans, etc.
- Test a strategy in the paper trading mode using historical data
- Test a strategy in the paper trading mode using live market data
- Trade (execute) a strategy in the live trading mode using live market data

Prerequisites

A basic knowledge of high-level programming languages is necessary in order to write a personal strategy. The framework is 100% pure Java and run on Windows, Linux and Mac OS X.

The Bonnot Gang offers free consultancy to support you in the writing and testing of new strategies. Please see chapter "Support & Help".

Functionalities

Core Framework

- 100% Java
- Scalable and extensible
- Event driven architecture
- Supports Siddhi & Esper CEP
- Basic persistence layer embedded inside the framework
- Add on persistence layer supports
- High Level Trade System class
- *High Level Event Study class **

The core framework of the tbg-Quant platform is very extensible. It is possible to easily add third party code libraries (third-party mathematical analysis software).

tbg-QuantDesk

- Web application interface (HTML5)

Supported Brokers

- Paper Broker
- Interactive Brokers

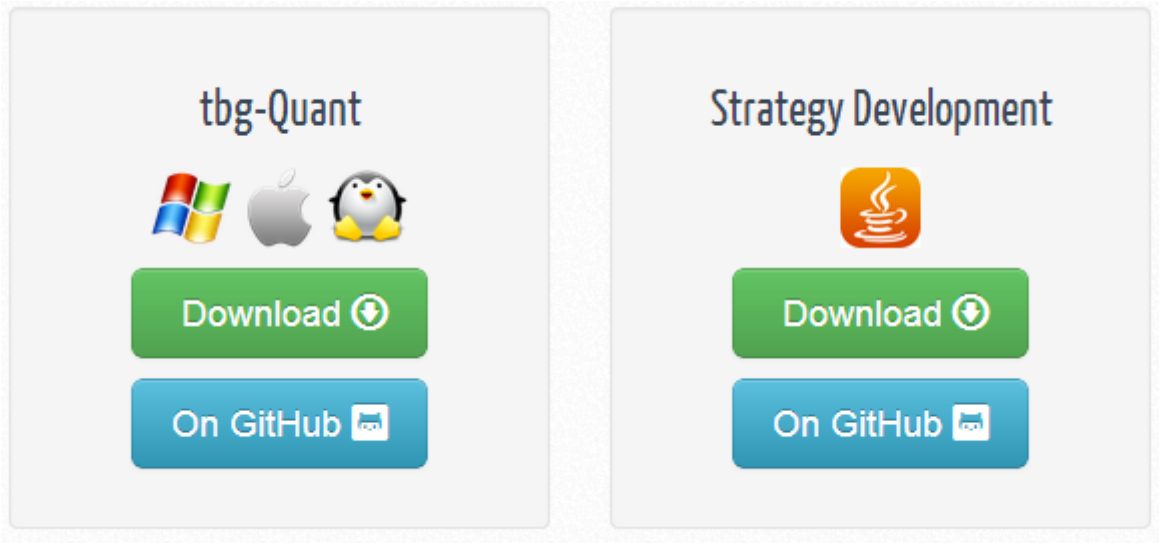
Market Data Feeds

- Yahoo daily, weekly and monthly
- *Google daily, weekly and monthly **
- CSV custom data
- The Bonnot Gang, 1 minute candles
- Interactive Brokers

(*) Not yet available, contact us for details

Download

tbg-Quant platform can be downloaded from the Bonnot Gang website or on GitHub.



There are 2 main components:

1. tbg-Quant platform

This is the platform's framework, which provides all basic functionalities.

The package includes some simple demo strategies and works on Windows, Linux and Max OSX.

2. tbg-Quant-Strategy-Development

This is the development environment to create strategies, it is a ready to go eclipse project package. It includes some sample strategies with full source code.

Download Link: http://thebonnotgang.com/tbg/algotrading/

Logical Data Model

The diagram below demonstrates the tbg-Quant platform logical data model.

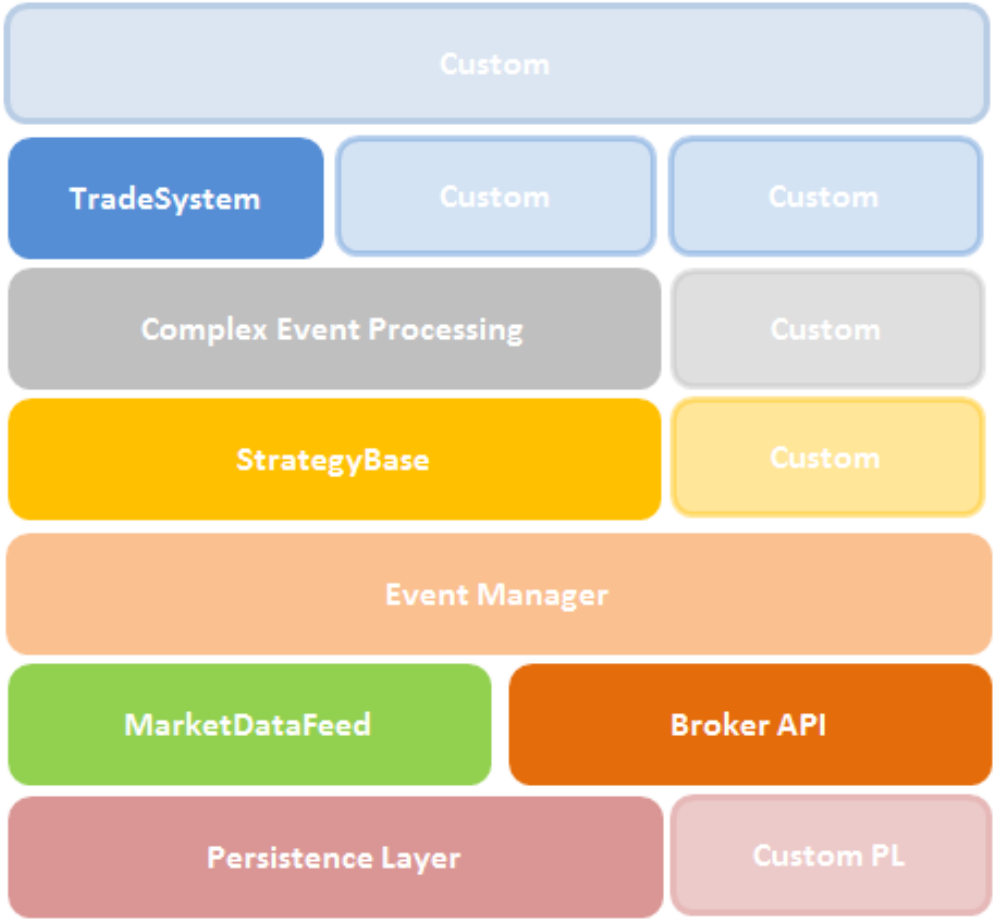


Figure 1 - tbg-Quant logical data model

System Use Case Scenario

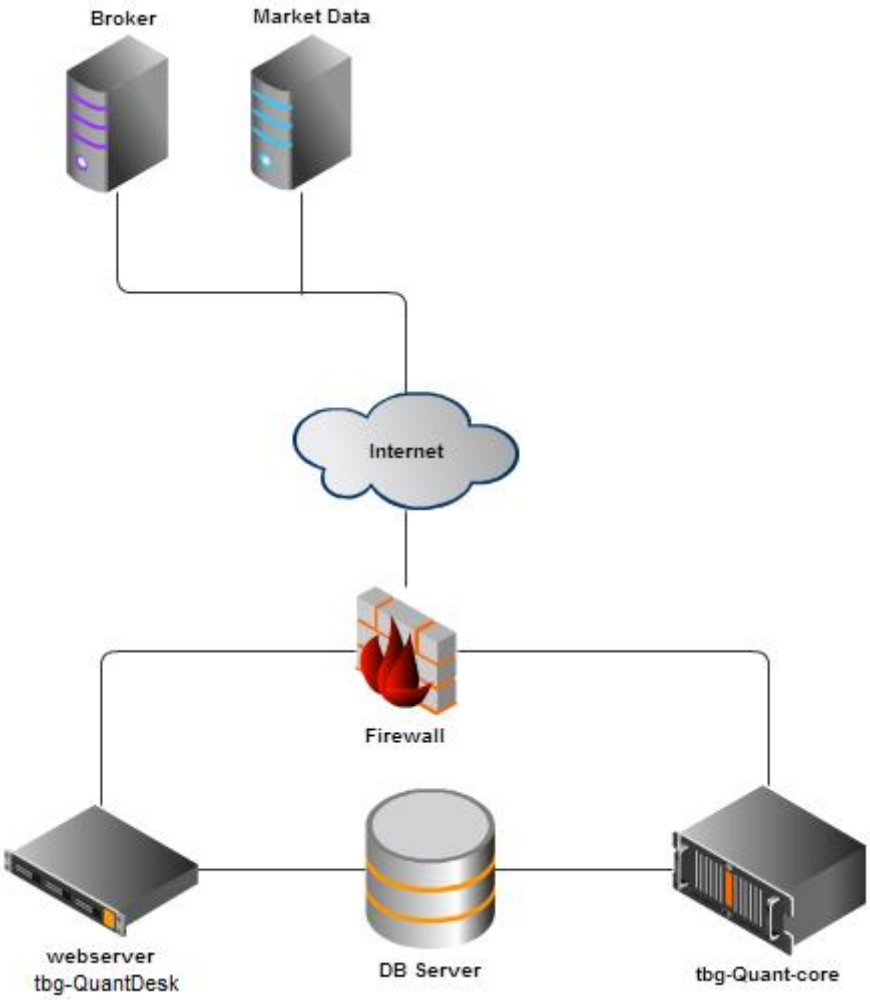


Figure 2 - tbg-Quant Platform scenario

Support & Help

The Bonnot Gang provides ***free*** assistance in coding and testing strategies. All requests are carefully evaluated and priority is given based on project importance. The Bonnot Gang reserves the right to provide assistance based on its own discretion.

Please contact us to discuss your project needs.

To ensure confidentiality, a non-disclosure agreement will be signed.

A user community is also available to exchange information.
http://thebonnotgang.com/tbg/support/

Contacts

The Bonnot Gang

Web : http://thebonnotgang.com/
e-maill : info@thebonnotgang.com
Blog : http://thebonnotgang.com/tbg/blog/
Community : http://thebonnotgang.com/tbg/support/community/
LinkedIn : http://www.linkedin.com/company/the-bonnot-gang/

Platform Licence

TBG-QUANT SOFTWARE LICENSE AGREEMENT

This is a legal agreement between you and TBG-QUANT Software (The Bonnot Gang) covering your use of TBG-QUANT (the "Software").

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Set-up

This chapter covers tbg-Quant platform basic installation and configuration for Windows, Linux and Mac OS X. It does not cover final configuration for live execution (for this purpose please check the online community forums).

Download & Install tbg-Quant platform

Requirements

The tbg-Quant platform requires the SUN Java Virtual Machine (JVM >1.6).
Please ensure that your system enables JVM or go to the following website, download and install the latest JVM:

www.java.com/getjava

OpenJDK Runtime Environment is also a good alternative to the SUN JVM.

http://openjdk.java.net/

Downloads

You can download the tarball/zip package or clone the GitHub repository.

There are 2 main packages:

- **tbg-Quant**
  The binary package, ready to go production environment.

- **tbg-Quant-Strategy-Development**
  This package contains source code of many strategy examples and it is a good starting point for strategy developers. It does not need the tbg-Quant package because libraries are already embedded.

Download and Execute

If you download the zip package, you just need to unzip it.
If you want to clone the GitHub repository, please follow the below instructions:

```
$ git clone https://github.com/tbg-quant/tbg-quant.git
Cloning into 'tbg-quant'...
remote: Counting objects: 339, done.
remote: Compressing objects: 100% (127/127), done.
remote: Total 339 (delta 209), reused 325 (delta 203)
Receiving objects: 100% (339/339), 6.47 MiB | 56 KiB/s, done.
Resolving deltas: 100% (209/209), done.
$ cd tbg-quant/
/tbg-quant$
/tbg-quant$ ll
total 48
drwxr-xr-x 7 sfl sfl 4096 Apr 24 15:34 ./
drwxrwxr-x 3 sfl sfl 4096 Apr 24 15:32 ../
-rw-rw-r-- 1 sfl sfl 2616 Apr 24 15:34 3rdparty_license.txt
drwxrwxr-x 2 sfl sfl 4096 Apr 24 15:34 config/
drwxrwxr-x 3 sfl sfl 4096 Apr 24 15:34 documentation/
drwxrwxr-x 8 sfl sfl 4096 Apr 24 15:34 .git/
drwxrwxr-x 2 sfl sfl 4096 Apr 24 15:34 lib/
-rw-rw-r-- 1 sfl sfl 2067 Apr 24 15:34 LICENSE.TXT
-rw-rw-r-- 1 sfl sfl  151 Apr 24 15:34 README.md
drwxrwxr-x 2 sfl sfl 4096 Apr 24 15:34 tbg/
-rwxr-xr-x 1 sfl sfl   75 Apr 24 15:34 Test.bat*
-rwxr-xr-x 1 sfl sfl   63 Apr 24 15:34 Test.sh*
/tbg-quant$ ./Test.sh

TESTING tbgQuant platform ...


------------------------------------------------------------------------
tbg-Quant core version 1.1beta4      -      (c) www.thebonnotgang.com
------------------------------------------------------------------------
../config/tbg-Quant.properties not found, checking ClassPath...
tbg-Quant.properties loaded from ClassPath.
Cannot find config.proprieties file, proceeding without it.
Found 2 symbols!
Strategy ID : tbgQuant_test
Strategy Dummy TradingSystem started [Wed Apr 24 15:40:05 EDT 2013]
Strategy Description: Dummy Description
START
```

```
Using default storeService...DEFAULT_STORESERVICE
RunID: [UserID:tbg][RunID:1][Description:Dummy Description][StrategyName:Dummy
TradingSystem][StrategyClass:tbgQuant_test]
No MarketDataEvent specified! proceding using default: TICK_EVENT
Pass-Through CEP Provider
Connected to PaperBroker.
Connected to BogusMarketDataFeeder.
CVX subscribed.
XOM subscribed.
Active MarketDataFeed...
Time: Wed Apr 24 15:40:10 EDT 2013 Symbol: XOM Price: 360.0511993017197 Size: 1.0 Volume: 591
AskPrice: 360.19037696308396 BidPrice: 360.3187115049494 askSize: 71.0 bidSize: 29.0
[…]
STOP
Connection to BogusMarketDataFeeder closed.
Connection to PaperBroker closed.
Elaborated in 0 Days 0 Hours 0 Minutes 27 Seconds (27986 millis).
H2 Connection safely Closed.
STRATEGY STOPPED.
/tbg-quant$
```

If you see this output means that tbg-Quant platform is properly installed.

Running an example strategy

Once you installed the platform, you can run some sample strategies included.
The ***strategies-repo*** folder contains the strategies binaries. The ***bin*** folder contains the executable, both for windows or *nix operating systems.

Running the Turn of the Month Strategy "ToM_Strategy"

Inside the bin folders you should find ToM_Strategy.bat and ToM_Strategy.sh, Windows and Linux executable.

```
tbg-quant/bin$ ./ToM_Strategy.sh
```

```
--------------------------------------------------------------------------------
tbg-Quant core version 1.1beta4     -     (c) www.thebonnotgang.com
--------------------------------------------------------------------------------
Cannot find config.proprieties file, proceeding without it.
Strategy ID : ToM_Strategy
Strategy Turn of the Month Strategy started [Fri Apr 26 10:57:01 EDT 2013]
Strategy Description: Strategy that try to exploit the well known Turn of the Month effect.
START
Using default storeService...DEFAULT_STORESERVICE
RunID: [UserID:tbg][RunID:1][Description:Strategy that try to exploit the well known Turn of the Month
effect.][StrategyName:Turn of the Month Strategy][StrategyClass:ToM_Strategy]
MarketDataEventType setted to CANDLE_EVENT
Pass-Through CEP Provider
Connected to PaperBroker.
Connected to YahooMarketDataFeed.
Fetching SPY from Yahoo...
Active MarketDataFeed...
EVENT: Wed Jan 26 00:00:00 EST 2000 FILLED ORDER 1 qta: 71.0 Action: BUY Filled: 71 @Price:140.81 symbol: SPY
EVENT: Thu Feb 03 00:00:00 EST 2000 FILLED ORDER 2 qta: 71.0 Action: SELL Filled: 71 @Price:143.19 symbol: SPY
EVENT: Mon Feb 28 00:00:00 EST 2000 FILLED ORDER 3 qta: 73.0 Action: BUY Filled: 73 @Price:136.13 symbol: SPY
```

[…]

```
Sending orders to close open position...
EVENT: Fri Dec 30 00:00:00 EST 2011 FILLED ORDER 288 qta: 79.0 Action: SELL Filled: 79 @Price:125.5 symbol: SPY
All positions have been closed.
>---------------------------------- ACCOUNT ----------------------------------<
ACCOUNT_CODE:PaperAccount
ACCOUNT_TYPE:Standard
CURRENCY:USD
INITIAL_CAPITAL:12000.0
CASH_BALANCE:18190.86
INVESTED_CAPITAL:0.0
REALIZED_PNL:-78.21
UNREALIZED_PNL:0.0
EQUITY_PNL:6190.86
>---------------------------------- PORTFOLIO ----------------------------------<
No position opened.
>---------------------------------- STATS ----------------------------------<
```

```
Initial Capital    :  12000.0
Ending  Capital    :  18190.86
Total Profit & Loss :  6190.86 ( 51.59 % )
P&L Standard Dev.  :  293.03
Annual Return      :  515.9 ( 4.29 % )
Sharpe Ratio       :  1.76
Profit Factor      :  1.71
Total Trades       :  144
Winners            :  91 ( 63.19 % )
Losers             :  53 ( 36.8 % )
Equals             :  0 ( 0.0 % )
Open Trades        :  0
Average Trade      :  42.99
Avg Winner Trade   :  200.37
Avg Loser  Trade   :  -227.23
Max Winner Trade   :  1566.03
Max Loser  Trade   :  -861.82
>--------------------------------------  LONG  --------------------------------------<
Long Profit & Loss      :     6190.86 ( 51.59 % )
Long P&L Standard Dev.  :     293.03
Long Annual Return      :     515.9 ( 4.29 % )
Long Sharpe Ratio       :     1.76
Long Profit Factor      :     1.71
Long Total Trades       :     144
Long Winners            :     91 ( 63.19 % )
Long Losers             :     53 ( 36.8 % )
Long Equals             :     0 ( 0.0 % )
Long Open Trades        :     0
Long Average Trade      :     42.99
Long Avg Winner Trade   :     200.37
Long Avg Loser  Trade   :     -227.23
Long Max Winner Trade   :     1566.03
Long Max Loser  Trade   :     -861.82
>--------------------------------------  SHORT  --------------------------------------<
Short Profit & Loss      :    0.0 ( 0.0 % )
Short P&L Standard Dev.  :    0.0
Short Annual Return      :    0.0 ( 0.0 % )
Short Sharpe Ratio       :    0.0
Short Profit Factor      :    0.0
Short Total Trades       :    0
Short Winners            :    0 ( 0.0 % )
Short Losers             :    0 ( 0.0 % )
Short Equals             :    0 ( 0.0 % )
Short Open Trades        :    0
Short Average Trade      :    0.0
Short Avg Winner Trade   :    0.0
Short Avg Loser  Trade   :    0.0
Short Max Winner Trade   :    0.0
Short Max Loser  Trade   :    0.0
>---------------------------------- ------------ ----------------------------------<
STOP
Connection to YahooMarketDataFeed closed.
Connection to PaperBroker closed.
Elaborated in 0 Days 0 Hours 0 Minutes 9 Seconds (9550 millis).
H2 Connection safely Closed.
STRATEGY STOPPED.

tbg-quant/bin$
```

Try to run the **ToM_Strategy** example. It will try to connect to the internet and fetch historical data from Yahoo Finance website.

If you are behind a corporate firewall, please configure the proxy values in the Java Control Panel.

Included examples and source code

Details about included examples can be found here:

https://github.com/asfolcini/tbg-quant-strategy-development/blob/master/README.md

Domain Model Components

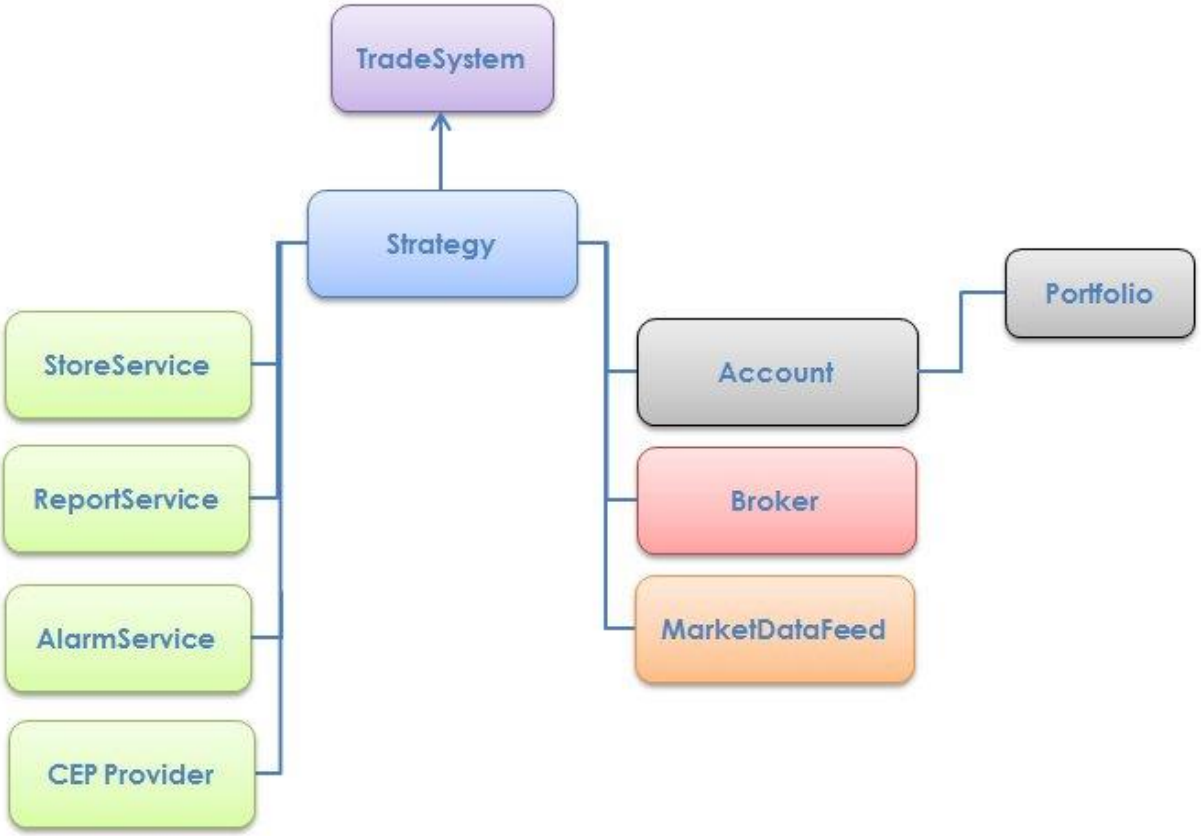
After reading this chapter, you will get familiar with the main components of tbg-Quant core framework and how to use them.

There are two categories, shown below:

- **Main Components**
  - Account
    - Portfolio
  - Broker
    - Order
  - MarketDataFeed
    - MarketDataEvent
  - Strategy
  - Trade System

- **Services**
  - StoreService
  - ReportService
  - AlarmService
  - CEP Provider
  - Utils

The Model


TradeSystem
Strategy
StoreService
ReportService
AlarmService
CEP Provider
Account
Portfolio
Broker
MarketDataFeed

Account

This represents the trading account.
Main feature:

- **Account ID**
  Identify the unique ID of the account.
- **Currency**
  The currency of the account
- **Initial Capital**
  Is the starting initial capital (cash) available.
- **Cash Balance**
  Is the capital (cash) available at a given moment.
- **Invested Capital**
  Is the amount of capital (cash) currently invested.
- **Realized PNL (Profit & Loss)**
  Is the realized profit & loss made by close investments.
- **Unrealized PNL (Profit & Loss)**
  Is the current profit & loss due to a current investment.
- **Equity PNL (Profit & Loss)**
  Is the total profit & loss.

Account Implementations

- ***PaperAccount***, used for paper trading
- ***IBAccount***, InteractiveBrokers account

Declaration

```
// set the PaperAccount, $20000 initial capital
private final PaperAccount account = new PaperAccount(20000, Currency.USD);
```

```
// set the PaperAccount, €20000 initial capital, default currency is euro
private final PaperAccount account = new PaperAccount(20000);
```

```
// set the PaperAccount with default initial capital (1ml euro)
private final PaperAccount account = new PaperAccount();
```

Portfolio

Through Account entity you can access to Portfolio entity which keep tracks of all open positions.

```
account.getPortfolio();
```

Return a list of open positions.

```
account.getPortfolioPosition(symbol);
```

Return the position for the security *symbol*.

Broker

This is the entity that executes orders.
Main features:

- **Connect to the Broker**
- **Disconnect from the Broker**
- **CancelOrder**
- **SendOrder to the Broker**
  Sends Order to be fulfilled.

Broker Implementations

- ***PaperBroker***
  For paper trading.
  Possibility to specify commission cost and slippage.
  At this stage every order passed to the PaperBroker will be full filled and executed.
  PaperBroker handles only MARKET Orders.

- ***IBBroker via API***
  InteractiveBrokers implementation for live trading.

- ***FIX Protocol***
  To be implemented, please contact us for more details.

Declaration

```
private final IBroker broker = new PaperBroker(account);
{
        broker.setBrokerCommissions(SecurityType.STK, 10.0);
        broker.setSlippage(0.5);
}

/**
 * Sets the InteractiveBrokersAdapter
 */
private final InteractiveBrokersAdapter interactiveBrokersAdapter = new InteractiveBrokersAdapter();

/**
 * Sets the broker
 */
private final IBroker broker = new IBBroker(account,interactiveBrokersAdapter);
{
        broker.setDebug(true);
        broker.setBrokerId(1);
}
```

Sending Orders

```
// Open position
Order order = new Order();
order.setSecurity(getSecurityBySymbol("IBM"));
order.setOrderSide(OrderSide.BUY);
order.setOrderType(OrderType.MARKET);
order.setQuantity(100);

broker.sendOrder(order);
```

Sending a MARKET order to BUY 100 shares of IBM.

Cancel Order

```
broker.cancelOrder(orderId);
```

Sending a CANCEL ORDER to the broker.

You can access this functionality using the TradingSystem high-level method:

```
cancelOrderForSymbol(security.getSymbol());
```

Order

An order is an instruction to a Broker to BUY or SELL a security.
Attributes:

- **Order ID**
  Unique ID of an order.
- **Order Type**
  MARKET ,
  LIMIT,
  STOP,
  STOP_LIMIT
  TRAILING_STOP
- **Security**
- **Order Side**
  BUY
  SELL
  SHORT_SELL
- **Time In Force**
  Specify how long the order will remain active before it is executed or expires.
- **Target TimeStamp**
- **Expiration TimeStamp**
- **Quantity**
  Number of shares to BUY/SELL
- **Limit Price**
- **Stop Price**
- **Trailing Distance**
- **Order Status**
  NEW, Order is new, never submitted to the broker.
  PENDING_SUBMIT, Order has been sent to the broker.
  PROCESSING, Order has been submitted by the broker and is now processed.
  FILLED, Order is filled, only if is complete. Partial filling is not considered a filled order. This is a terminal state.
  REJECTED, Order has been rejected by the broker. This is a terminal state.
  CANCELED, Order cancelled. Order may still be partially filled.
  PENDING_CANCEL, User requested to cancel this Order. Broker received the request, but is still evaluating the request.
  EXPIRED, Order has expired.

Declaration

```
Order order = new Order();
order.setSecurity(security);
order.setOrderSide(OrderSide.BUY);
order.setOrderType(OrderType.MARKET);
order.setQuantity(10.0);
order.setTimeInForce(OrderTIF.DAY);
```

Market Order, valid for the day, BUY 10 shares of security.

```
Order order = new Order();
order.setSecurity(security);
order.setOrderSide(OrderSide.SHORT_SELL);
order.setOrderType(OrderType.MARKET);
order.setQuantity(1000);
order.setTimeInForce(OrderTIF.DAY);
```

Market Order, valid for the day, SELL SHORT 1000 shares of security.

MarketDataFeed

This component provides market data, both historical or live data.
Main features:

- Connect to MarketDataFeed
- Disconnect from MarketDataFeed
- **Subscribe market data for a security**
  Require a data subscription for a given security
- **Activate a market data subscription**
  Activate the subscriptions and begin to receive market data
- **Set the market data Event**
  Set which type of market event we should expect.
  There are two MarketEvent: the TickEvent and the CandleEvent.

MarketDataFeed Implementations

- ***BogusMarketDataFeed***
  Provides random fake data.
  Supports TickEvents and CandleEvents.

- ***YahooMarketDataFeed***
  Provides historical data from Yahoo Finance.
  DAILY, WEEKLY, MONTHLY
  CandleEvents only

- ***GoogleMarketDataFeed*** (* not available in beta release)
  Provides historical data from Google Finance.
  DAILY, WEEKLY, MONTHLY
  CandleEvents only

- ***TBGMarketDataFeed***
  Provides original 1 minute candles from theBonnotGang historical database.
  1 MINUTE CANDLES
  Supports original CandleEvent and TickEvents (built on 1 minute candles).

- ***IBMarketDataFeed***
  Provides interface to InteractiveBrokers live market data.
  Supports TickEvents.

Declaration

```
private final IMarketDataFeed marketDataFeed = new BogusMarketDataFeed();
```

Bogus Feed.

```
private final YahooMarketDataFeed marketDataFeed = new YahooMarketDataFeed();
{
	/**
	 * Sets the historical daily data from Yahoo
	 * From : DD , MM , YYYY
	 * To   : DD , MM , YYYY
	 * Yahoo provides DAILY, WEEKLY and MONTHLY
	 */
	marketDataFeed.setYahooParameters("01", "01", "2008",
	                                  "31", "12", "2010",
	                                  marketDataFeed.YAHOO_DAILY);
}
```

Yahoo, historical DAILY data from 1/1/2008 to 31/12/2010.

```
private final TBGMarketDataFeed marketDataFeed = new TBGMarketDataFeed();
{
	marketDataFeed.setMarketDataFeedId(112);
	marketDataFeed.setTbgMode(TBGMarketDataFeed.TBG_MODE_ONLINE);
	marketDataFeed.setTBGParameters("3", "8", "2011", "17", "9", "2012");
	// set the MarketDataEvent type, trades or candles ?
	//marketDataFeed.setMarketDataEvent(MarketDataEventType.TRADE_EVENT);
	marketDataFeed.setMarketDataEvent(MarketDataEventType.CANDLE_EVENT);
}
```

TheBonnotGang Feed, 1 minute candles from 3/8/2011 to 17/9/2012.

```
private final InteractiveBrokersAdapter interactiveBrokersAdapter = new InteractiveBrokersAdapter();

private final IBMarketDataFeed marketDataFeed = new IBMarketDataFeed(interactiveBrokersAdapter);
```

InteractiveBrokers Feed.

MarketDataEvent

A market data event can be categorized in two types: TickEvent and CandleEvent.

TickEvent

Contains the last Ask & Bid Price of a security and the last price which the security traded at.

- Symbol
- Price
- Size
- Volume
- Timestamp
- AskPrice
- AskSize
- BidPrice
- BidSize

CandleEvent

Contains the open, close, high and low price of a certain period of time.

- Symbol
- Timestamp
- OpenPrice
- HighPrice
- LowPrice
- ClosePrice
- Volume

Declaration

```
private final IMarketDataFeed marketDataFeed = new XXXMarketDataFeed();
{
	//marketDataFeed.setMarketDataEvent(MarketDataEventType.TRADE_EVENT);
	marketDataFeed.setMarketDataEvent(MarketDataEventType.CANDLE_EVENT);
}
```

MarketDataEvent should be setted in according with the MarketDataFeed implementation.

Strategy

The Strategy entity is one of the main components, it can be used through the TradingSystem entity. Even if is possible to directly access to the Strategy component we suggest to use the TradingSystem component because it adds some useful utilities and hides the logical parts.

In the Strategy context four different events can happen:

- **onStart**
  Event generated at the start of the strategy.

- **onStop**
  Event generated at the stop of the strategy.

- **onEvent**
  Event generated upon receipt of a market event (CandleEvent or TickEvent).

- **onError**
  Event generated upon the occurrence of an error.

Declaration

```
public class EmptyStrategy implements IStrategy {

	@Override
	public void onStart() {
	}

	@Override
	public void onStop() {
	}

	@Override
	public void onEvent(Object event) {
	}

	@Override
	public void onError(Messages msg) {
	}
}
```

This is an empty Strategy skeleton.

TradingSystem

TradingSystem is the main object to be used when you want to implement a new strategy, it contains a number of basic functions and a set of utility functions.

- **TradingSystemName**
- **TradingSystemDescription**
- **TradingSystemParameter**
  Loads a parameter value from the external parameter configuration file.
- **getSecurityBySymbol**
  Returns the security object from its symbol.
- **closeAllOpenPositions**
  It closes all the open position in portfolio.
- **closePositionForSymbol**
  It closes a position for a given symbol.
- **scheduleReportGeneration**
  Permits to generate a report every X seconds.
- **getSharesFor**
  Returns a number of shares for a given amount of money.
- **TrendTracker**
  Keep track of the trend for a given symbol.
- **PositionTracker**
  Keep track if a position is open in which side for a given symbol
- **Subscribe Securities**
  Subscribe a security or a list of securities to the MarketDataFeed.

Declaration

```
public class EmptyTS extends TradingSystem {

	public EmptyTS(){
		setTradingSystemName("Empty TS");
		setTradingSystemDescription("Empty Trade System");
	}

	public static void main(String[] args) {
		new EmptyTS().start();
	}
}
```

This is a minimal empty TradingSystem.

How it all goes togheter

It's time to tie all together and build a working strategy skeleton.

First, we tie **TradingSystem** and **Strategy** togheter.

```
public class MySkelStrategy extends TradingSystem implements IStrategy {

	public MySkelStrategy(){
		setTradingSystemName("My Skeleton Strategy");
		setTradingSystemDescription("Use this to build something more unique!");

	}

	@Override
	public void onStart() {
		// On Strategy starts
	}

	@Override
	public void onStop() {
		// On Strategy stops
	}

	@Override
	public void onEvent(Object event) {
		// On MarketEvent
	}

	@Override
	public void onError(Messages msg) {
		// On Error occurs
	}

	public static void main(String[] args) {
		new MySkelStrategy().start();
	}
}
```

Then, we add the **Account**, the **Broker** , the **MarketDataFeed** and some **securities**.

We use the implementation of PaperAccount, PaperBroker and BogusMarketDataFeed.

```
public class MySkelStrategy extends TradingSystem implements IStrategy {

	private final PaperAccount account = new PaperAccount();
	private final IBroker broker = new PaperBroker(account);
	private final BogusMarketDataFeed marketDataFeed = new BogusMarketDataFeed();

	public MySkelStrategy(){
		setTradingSystemName("My Skeleton Strategy");
		setTradingSystemDescription("Use this to build something more unique!");
		setBroker(broker);
		setMarketDataFeed(marketDataFeed);
		subscribeSecurities(new LoadSecurities(SecurityType.STK, "SMART",
				Currency.USD,"XOM,WMT,AAPL").getSecurities());
	}

	@Override
	public void onStart() {
		// On Strategy starts
	}

	@Override
	public void onStop() {
		// On Strategy stops
	}

	@Override
	public void onEvent(Object event) {
		// On MarketEvent
	}

	@Override
	public void onError(Messages msg) {
		// On Error occurs
	}

	public static void main(String[] args) {
		new MySkelStrategy().start();
	}
}
```

We added 3 securities: Exxon (XOM), WalMart (WMT) and Apple (AAPL).
If we execute this strategy we obtain this output:

```
WARN - Cannot find config.proprieties file, proceeding without it.
INFO - Found 3 symbols!
INFO - Strategy My Skeleton Strategy started [Wed Jan 16 12:07:41 CET 2013]
INFO - Strategy Description: Use this strategy to build something more unique!
INFO - Using default storeService...DEFAULT_STORESERVICE
INFO - RunID: [UserID:tbg][RunID:NA][Description:][StrategyName:][StrategyClass:]
WARN - No MarketDataEvent specified! proceding using default: TRADE_EVENT
INFO - Initializing engine URI 'CEPEngine' version 4.3.0
INFO - Connected to PaperBroker.
INFO - Connected to BogusMarketDataFeeder.
INFO - XOM subscribed.
INFO - WMT subscribed.
INFO - AAPL subscribed.
INFO - Active MarketDataFeed...
```

Everything is working properly but we cannot see any market data coming in, this is because we did not implemented the ***onEvent***() method.
Let's do this:

```
	@Override
	public void onEvent(Object event) {
		// On MarketEvent
		Log.info(event);
	}
```

… and this is the output :

```
WARN - Cannot find config.proprieties file, proceeding without it.
INFO - Found 3 symbols!
INFO - Strategy My Skeleton Strategy started [Wed Jan 16 12:07:41 CET 2013]
INFO - Strategy Description: Use this strategy to build something more unique!
INFO - Using default storeService...DEFAULT_STORESERVICE
INFO - RunID: [UserID:tbg][RunID:NA][Description:][StrategyName:][StrategyClass:]
WARN - No MarketDataEvent specified! proceding using default: TRADE_EVENT
INFO - Initializing engine URI 'CEPEngine' version 4.3.0
INFO - Connected to PaperBroker.
INFO - Connected to BogusMarketDataFeeder.
INFO - XOM subscribed.
INFO - WMT subscribed.
INFO - AAPL subscribed.
INFO - Active MarketDataFeed...
INFO - Time: Wed Jan 16 12:16:51 CET 2013 Symbol: AAPL Price: 316.9450596285343 Size: 1.0 Volume:
40 AskPrice: 316.87728439677926 BidPrice: 316.99397713513684 askSize: 46.0 bidSize: 17.0
INFO - Time: Wed Jan 16 12:16:51 CET 2013 Symbol: AAPL Price: 317.0716115562461 Size: 1.0 Volume:
26 AskPrice: 317.09253483060394 BidPrice: 317.1575639435422 askSize: 8.0 bidSize: 86.0
INFO - Time: Wed Jan 16 12:16:51 CET 2013 Symbol: WMT Price: 251.992572631073 Size: 1.0 Volume:
876 AskPrice: 251.98062041540038 BidPrice: 252.05596636994105 askSize: 15.0 bidSize: 11.0
INFO - Time: Wed Jan 16 12:16:51 CET 2013 Symbol: AAPL Price: 317.11020039359397 Size: 1.0
Volume: 738 AskPrice: 317.0997902705789 BidPrice: 317.1181056974891 askSize: 91.0 bidSize: 94.0
INFO - Time: Wed Jan 16 12:16:51 CET 2013 Symbol: AAPL Price: 317.02883432536305 Size: 1.0
Volume: 587 AskPrice: 316.99733044360397 BidPrice: 316.91270027859775 askSize: 19.0 bidSize: 62.0
[...]
[...]
```

Store Service

The storeService handles the storing of the persistence data like Account information, history of Orders, Executions, Open & Close Positions, etc…

By default the tbg-Quant Strategy is using an embedded database called H2DB, is anyway possible to use a custom interface to MySQL, Oracle, MSSQL, etc…

The use of a persistence layer is not required in order to execute a strategy but is strongly recommended.

Features:

- StoreAccount
- StorePosition
- StoreHistoricalPosition
- StoreExecution
- StoreOrder
- StoreSecurity
- StoreMap

Intraday Data

Note that even if you can use the storeService to save market quotes this is not an advisable option because relational databases are not suitable for storage of huge time series. We will provide a dedicated service to storing market quotes.

Implementations

- ***MockStoreService***
  Specify to use this storeService implementation if you do not want to use a storeService. *We strongly suggest not to use this implementation.*

- ***H2DBStoreService***
  This is the default implementation, you do not need to specify it.

- ***MySQLStoreService*** (* not available in beta release)
  Optional service uses an external MySQL DB.

- ***CSVStoreService***
  Saves to CSV file format, very basic implementation.
  We strongly suggest not to use this implementation.

Report Service

This is an highly customizable component for producing reports.

executeReport() is the main method to implement.

Implementations

- ***TextReportService***
  Produces very simple report in 3 way:
  - Output only
  - Save to File only
  - Output & Save to File

Declaration

```
private final IReportService reportService = new TextReportService();
{
	reportService.setReportType(ReportType.OUTPUT_ONLY);
}
```

```
private final IReportService reportService = new TextReportService("C:\\test\\");
{
	reportService.setReportType(ReportType.OUTPUT_AND_STORE);
}
```

It will show the output report and will write a txt file in C:\test\.

Alarm Service

Not yet implemented.

CEP Provider

Complex event processing (CEP) delivers high-speed processing of many events across all the layers of an organization, identifying the most meaningful events within the event cloud, analyzing their impact, and taking subsequent action in real time.
tbg-Quant supports CEP through 2 engines: Siddhi and Esper.

Implementations

- **PassThrough Provider**
  Used by default it simply forward all the input events to the output without filtering.

- **Siddhi CEP engine** http://wso2.com/products/complex-event-processor/

  Siddhi CEP is a lightweight, easy-to-use Open Source Complex Event Processing Engine (CEP) under Apache Software License v2.0. Siddhi CEP processes events which are triggered by various event sources and notifies appropriate complex events according to the user specified queries. Siddhi was started as a research project initiated at University of Moratuwa, Sri Lanka,and now being improved by WSO2 Inc.

  tbg-Quant package embeds the Siddhi library.

- **Esper CEP engine** http://www.espertech.com

  Esper is a component for complex event processing (CEP).
  Esper and Event Processing Language (EPL) provide a highly scalable, memory-efficient, in-memory computing, SQL-standard, minimal latency, real-time Big Data processing engine for medium to high-velocity and high-variety data.
  The Event Processing Language (EPL) is a declarative language for dealing with high frequency time-based event data.

  Esper library is not embedded in the tbg-Quant package, you need to download the esper-X.y.z.jar library and add it to the tbg-Quant library (lib/) folder.

Declaration

Siddhi

```
/**
 * Sets CEP Provider, using SIDDHI
 */
private ICEPProvider CEP = new SiddhiCEPProvider(this);
{
	final String [] QUERY = {
		"from candleStream [win.time(100)] ",
		"insert into candle symbol, closePrice, avg(closePrice) as avgClose, volume as vol",
		"group by symbol"
	};
	CEP.setCepQuery(QUERY);
}


/**
 * Costructor
 */
public HelloSiddhi() {
	[...]
	setCEPProvider(CEP);
}
```

Esper

```
/**
 * Sets CEP Provider, using ESPER
 */
private ICEPProvider CEP = new EsperCEPProvider(this);
{
	final String [] QUERY = {
		"select symbol, price, avg(price) from tick.win:time_batch(5 sec)"
	};
	CEP.setCepQuery(QUERY);
}


/**
 * Costructor
 */
public HelloEsper() {
	[...]
	setCEPProvider(CEP);
}
```

For support about the EPL (Event Processing Languages) please refer to the Siddhi/Esper website.

Conclusion

In this chapter we saw the tbg-Quant model and the main components.

We went through the Account and Broker components, we talked about the MarketDataFeed and the Strategy and TradingSystem components.

We finally built a working Skeleton Strategy using the bogus market simulator (BogusMarketDataFeed) and the paper account and broker.

Now, you should be able to use this Skeleton code in order to build something more unique.

You can change the MarketDataFeed from Bogus to Yahoo for using daily or weekly data, or TBGMarketDataFeed for using 1 minute candles.

You can add some trading logic inside the *onEvent()* method, send orders to the PaperBroker and assessing the performances by checking the reports generated with the ReportService component.

In the next chapter "In Action", many aspects will be studied in more detail. We'll see how to write a simple moving averages crossover strategy.

In Action

After reading this chapter, you should be able to understand how to create a new strategy, how to test it and finally how to trade(execute) it.

Create, Test, Trade !

Create a Strategy

To create or edit a strategy you can chose between using the tbg-QuantDesk tool or your favourite IDE (like Eclipse, Net Beans, etc.).

Warning
Explain how to use and setup and IDE is not the goal of this chapter.
We are planning to release the free version of tbg-QuantDesk for late-2013.

Pre-Requisites

Download the tbg-quant-strategy-development or clone the repository from GitHub.
Once you have the environment downloaded you should be able to import the project in your favourite IDE.

Please follow the instructions below:

Eclipse IDE
http://help.eclipse.org/helios/index.jsp?topic=%2Forg.eclipse.platform.doc.user%2Ftasks%2Ftasks-importproject.htm

Netbeans IDE
http://netbeans.org/kb/docs/java/project-setup.html#existing-java-sources

Add the libraries

Once you imported the project into your IDE workspace, in order to compile it you have to add the libraries contained in the **lib** folder. Without this step you won't be able to compile any strategy.

Due to license restriction we cannot distribute some third party libraries, for this reason if you are planning to write your strategy using Esper CEP or MySQL or InteractiveBrokers API you need to download and manually add the library to the tbg-quant folder.
Here is the list of the libraries you might be consider to manually add:

- **Esper Library**
  Esper library is not included by default inside the tbg-quant library folder.
  If you want to use the Esper CEP you should include the Esper library, go to the Esper website http://www.espertech.com/download/index.php download the esper-X.y.z.jar and add it to the tbg-quant ***lib*** folder.

- **InteractiveBrokers API**

  IB API are not included by default inside the tbg-quant library folder.

  If you want to use IB as your broker, download IB API and add the jar to the tbg-quant ***lib*** folder.

- **MySQL Connector Library**

  If you want to use MySQL instead of H2 database, you should add the MySQL connector library to the tbg-quant library folder.

Create your first Strategy

The simpler way is to clone an already existing strategy.
For this purpose in the examples package you can find the ***Skeleton*** Strategy example.
Use it like a starting point to code something more unique.

A Typical Strategy Structure

Let's break down the Strategy main structure:

Declaration head

```
public class Skel extends TradingSystem implements IStrategy{
```

All the strategies must extend the TradingSystem class which implements the base strategy features.

Components declaration

```
	private final PaperAccount account = new PaperAccount(20000, Currency.USD);
	private final IBroker broker = new PaperBroker(account);
	private final IMarketDataFeed marketDataFeed = new BogusMarketDataFeed();
```

This section declares which component is going to be used: the account, the broker and the MarketDataFeed. We specify that our initial capital is $20000.

Setting up

```
	public Skel() {
		setTradingSystemName("Skel");
		setTradingSystemDescription("empty description");
		setBroker(broker);
		setMarketDataFeed(marketDataFeed);

		subscribeSecurities(new  LoadSecurities(SecurityType.STK,"SMART",
					Currency.USD, "IBM,XOM,AAPL,GOOG").getSecurities());
	}
```

This section is used to wire the components together.
TradingSystemName, Description, Broker, MarketDataFeed and Securities.

Actions start, stop, error, event

```
	@Override
	public void onStart() {
		log.info("START");
	}
```

What to do when the strategy starts ?

```
	@Override
	public void onStop() {
		log.info("STOP");
	}
```

What to do when the strategy stops ?

```
	@Override
	public void onError(Messages msg) {
		// TODO Auto-generated method stub
	}
```

What to do when some error occurs ?

```
	@Override
	public void onEvent(Object event) {
		log.info(event);
	}
```

What to do when an event (trade or candle) occurs ?

This is the most important method, when we receive a trade event, what are we going to do with it ?

onEvent() is the place where the strategy code is.

Starter

```
	public static void main(String[] args) {
		new Skel().start();
	}
```

In Action: SimpleMovingAverage crossover

Let's suppose we need to implement two SMA cross strategy system using daily data from Yahoo Finance.

Once we cloned the Skeleton TradingSystem we first need to change the MarketDataFeed from Bogus to Yahoo.

Set MarketDataFeed

Replace

```
	private final IMarketDataFeed marketDataFeed = new BogusMarketDataFeed();
```

with YahooMarketDataFeed and specify the period and the timeframe:

```
	private final YahooMarketDataFeed marketDataFeed = new YahooMarketDataFeed();
	{
		/**
		 * Sets the historical daily data from Yahoo
		 * From : DD , MM , YYYY
		 * To   : DD , MM , YYYY
		 * Yahoo provides DAILY, WEEKLY and MONTHLY
		 */
		marketDataFeed.setYahooParameters("01", "01", "2008",
		                                  "31", "12", "2010",
		                                  marketDataFeed.YAHOO_DAILY);
	}
```

At this point you should be able to run the strategy and get real historical data from Yahoo.

Set Securities

We target IBM & Apple Inc (which symbol is AAPL)

```
subscribeSecurities(new LoadSecurities(SecurityType.STK, "SMART", Currency.USD,
                                       "IBM,AAPL" ).getSecurities());
```

Strategy Core Logic

This is where we need to code our system strategy.

```
	@Override
	public void onEvent(Object event) {
		Log.info(event);
	}
```

First we declare our two moving average, 60 & 100 days:

```
SMA sma1 = new SMA(60);
SMA sma2 = new SMA(100);
@Override
public void onEvent(Object event) {
	log.info(event);
}
```

…then
we set inside the constructor the minimumPeriods equal to the period of the slow sma.
We cast the event to the CandleEvent because Yahoo provides daily candles.
We add the closeprice to our two moving averages.

```
SMA sma1 = new SMA(60);
SMA sma2 = new SMA(100);
@Override
public void onEvent(Object event) {
	//log.info(event);

	CandleEvent ce = (CandleEvent) event;
	String symbol  = ce.getSymbol();

	sma1.add(symbol, ce.getClosePrice());
	sma2.add(symbol, ce.getClosePrice());


	 // be sure we reached the minimun events
	if (getSystemActivation(symbol)){
	   // Buy & Sell logic here !!
	}
}
```

Inside the getSystemActivation() block we write our Buy&Sell logic.

Buy & Sell Logic:

BUY If position for symbol X does not exist and sma1 > sma2
SELL if position for symbol X exists and sma1<sma2

```
	if (sma1.getValue(symbol)>sma2.getValue(symbol))
		trendTracker.setTrendSide(symbol,TrendSide.UP);
	else
		if (sma1.getValue(symbol)<sma2.getValue(symbol))
			trendTracker.setTrendSide(symbol,TrendSide.DOWN);
		else
			trendTracker.setTrendSide(symbol,TrendSide.FLAT);
```

And here is the part where we decide to send the signal.

```
if (trendTracker.getTrendSide(symbol)==TrendSide.UP){
	if (positionTracker.getStatusForSymbol(symbol)==PositionTracker.NON_EXISTENT){
		log.info(ce.getTimeStamp().getDate() +
				" BUY "+symbol+" @"+ce.getClosePrice());
	}else{
		log.info(ce.getTimeStamp().getDate() +
				" SELL "+symbol+" @"+ce.getClosePrice());
	}

}
```

We write a log message with the signal BUY or SELL.

This is the output for this strategy ran with Yahoo daily data on IBM & AAPL between 1/1/2008 & 31/12/2010:

```
WARN - Cannot find config.proprieties file, proceeding without it.
INFO - Found 2 symbols!
INFO - Strategy Tutorial1 started [Mon Jan 14 18:02:49 CET 2013]
INFO - Strategy Description: empty description
INFO - START
INFO - Using default storeService...DEFAULT_STORESERVICE
INFO - RunID: [UserID:tbg][RunID:NA][Description:][StrategyName:][StrategyClass:]
INFO - MarketDataEventType setted to CANDLE_EVENT
INFO - Initializing engine URI 'CEPEngine' version 4.3.0
INFO - Connected to PaperBroker.
INFO - Connected to YahooMarketDataFeed.
INFO - Fetching IBM from Yahoo...
INFO - Fetching AAPL from Yahoo...
INFO - Active MarketDataFeed...
INFO - Tue May 27 00:00:00 CEST 2008 BUY AAPL @186.43
INFO - Mon Mar 31 00:00:00 CEST 2008 BUY IBM @115.14
INFO - Mon Aug 25 00:00:00 CEST 2008 SELL AAPL @172.55
INFO - Fri Mar 27 00:00:00 CET 2009 BUY AAPL @106.85
INFO - Wed Sep 03 00:00:00 CEST 2008 SELL IBM @118.34
INFO - Thu Feb 26 00:00:00 CET 2009 BUY IBM @88.97
INFO - Tue Sep 14 00:00:00 CEST 2010 SELL AAPL @268.06
INFO - Tue Sep 21 00:00:00 CEST 2010 BUY AAPL @283.77
INFO - Mon Mar 29 00:00:00 CEST 2010 SELL IBM @128.59
INFO - Tue May 11 00:00:00 CEST 2010 BUY IBM @126.89
INFO - Thu Jul 08 00:00:00 CEST 2010 SELL IBM @127.97
INFO - Wed Sep 01 00:00:00 CEST 2010 BUY IBM @125.77
INFO - Sending INVOKE_STOP...
INFO - STOP
INFO - Connection to YahooMarketDataFeed closed.
INFO - Connection to PaperBroker closed.
INFO - Elaborated in 4480.0 millis.
INFO - H2 Connection safely Closed.
INFO - STRATEGY STOPPED.
```

Now it is time to send orders to the Broker (PaperBroker) and see if this strategy is profitable.

Execute Orders

Create an order and invest 5000 USD

```
Order order = new Order();
order.setSecurity(getSecurityBySymbol(symbol));
order.setOrderSide(OrderSide.BUY);
order.setOrderType(OrderType.MARKET);
order.setQuantity(getSharesFor(5000, ce.getClosePrice()));

broker.sendOrder(order);
```

This code will send to the broker a BUY order at MARKET for the equivalent of 5000 USD shares of 'symbol'.

To close an open position you can both insert an opposite order or use the following command:

```
closePositionFor(symbol);
```

onStop()

By adding the command closeAllOpenPosition() you force the Strategy to close all the opened positions before stop.

```
	public void onStop(){
		log.info("onStop(): ");
		closeAllOpenPositions();
	}
```

This is the output:

```
INFO - Sending orders to close open position...
INFO - EVENT: Fri Dec 31 00:00:00 CET 2010 FILLED ORDER 13 qta: 39.0 Action: SELL Filled: 39
@Price:146.76 symbol: IBM
INFO - EVENT: Fri Dec 31 00:00:00 CET 2010 FILLED ORDER 14 qta: 17.0 Action: SELL Filled: 17
@Price:322.56 symbol: AAPL
INFO - Waiting positions to be closed...
INFO - All positions have been closed.
```

What we did

- Cloned the Skeleton Strategy example
- Changed BogusMarketDataFeed to YahooMarketDataFeed (Daily data from 1/1/2008 to 31/12/2010)
- Changed Securities to IBM & AAPL (Apple)
- Wrote the Buy&Sell logic based on two moving averages cross
- Sended the orders to the broker (PaperBaroker)
- Added the instruction to close the open positions before stop the strategy

You should now able to write your own simple Strategy, for questions, support and help please contact us or post on the community forum.

Test a Strategy

In order to test a strategy you should need to get some basic statistics.
This is done by using the **ReportService** service.

Let's add this service on the previous example.

In Action: Assessing SimpleMovingAverage crossover strategy

Add this lines just after the broker declaration

```
	private final IReportService reportService = new TextReportService();
	{
		reportService.setReportType(ReportType.OUTPUT_ONLY);
	}
```

And inject the service :

```
	public Tutorial1() {
		setTradingSystemName("Tutorial1");
		setTradingSystemDescription("empty description");
		setBroker(broker);
		setReportService(reportService);
		setMarketDataFeed(marketDataFeed);
		subscribeSecurities(new LoadSecurities(SecurityType.STK, "SMART",
					Currency.USD,"IBM,AAPL").getSecurities());
		setMinimunSystemPeriods(100);
	}
	}
```

And this line in the onStop() method:

```
	@Override
	public void onStop() {
		Log.info("STOP");
		closeAllOpenPositions();
		accountReport();
	}
```

By calling the accountReport() is possible to print a set of basic statistics useful to asses our strategy.

Now execute the Strategy, a full set of basic statistics will be printed at the end, just like the following log:

Account Report

```
INFO - >---------------------------------- ACCOUNT ----------------------------------<
INFO - ACCOUNT_CODE:PaperAccount
INFO - ACCOUNT_TYPE:Standard
INFO - CURRENCY:USD
INFO - INITIAL_CAPITAL:20000.0
INFO - CASH_BALANCE:30447.86
INFO - INVESTED_CAPITAL:0.0
INFO - REALIZED_PNL:0.0
INFO - UNREALIZED_PNL:0.0
INFO - EQUITY_PNL:10447.86
INFO - >--------------------------------   PORTFOLIO   --------------------------------<
INFO - No position opened.
```

Total Statistics (Long + Short)

```
INFO - >-----------------------------------  STATS  -----------------------------------<
INFO - Initial Capital     :        20000.0
INFO - Ending  Capital     :        30447.86
INFO - Total Profit & Loss :        10447.86 ( 52.23 % )
INFO - P&L Standard Dev.   :        2759.14
INFO - Annual Return       :        3482.62 ( 17.41 % )
INFO - Sharpe Ratio        :        1.43
INFO - Profit Factor       :        2.5
INFO - Total Trades        :        7
INFO - Winners             :        5 ( 71.42 % )
INFO - Losers              :        2 ( 28.57 % )
INFO - Equals              :        0 ( 0.0 % )
INFO - Open Trades         :        0
INFO - Average Trade       :        1492.55
INFO - Avg Winner Trade    :        2230.9
INFO - Avg Loser  Trade    :        -353.34
INFO - Max Winner Trade    :        7415.66
INFO - Max Loser  Trade    :        -356.46
```

Long Statistics

```
INFO - >-------------------------------------  LONG  ---------------------------------------<
INFO - Long Profit & Loss       :   10447.86 ( 52.23 % )
INFO - Long P&L Standard Dev.   :   2759.14
INFO - Long Annual Return       :   3482.62 ( 17.41 % )
INFO - Long Sharpe Ratio        :   1.43
INFO - Long Profit Factor       :   2.5
INFO - Long Total Trades        :   7
INFO - Long Winners             :   5 ( 71.42 % )
INFO - Long Losers              :   2 ( 28.57 % )
INFO - Long Equals              :   0 ( 0.0 % )
INFO - Long Open Trades         :   0
INFO - Long Average Trade       :   1492.55
INFO - Long Avg Winner Trade    :   2230.9
INFO - Long Avg Loser  Trade    :   -353.34
INFO - Long Max Winner Trade    :   7415.66
INFO - Long Max Loser  Trade    :   -356.46
```

Short Statistics

```
INFO - >-------------------------------------  SHORT  ---------------------------------------<
INFO - Short Profit & Loss       :  0.0 ( 0.0 % )
INFO - Short P&L Standard Dev.   :  0.0
INFO - Short Annual Return       :  0.0 ( 0.0 % )
INFO - Short Sharpe Ratio        :  0.0
INFO - Short Profit Factor       :  0.0
INFO - Short Total Trades        :  0
INFO - Short Winners             :  0 ( 0.0 % )
INFO - Short Losers              :  0 ( 0.0 % )
INFO - Short Equals              :  0 ( 0.0 % )
INFO - Short Open Trades         :  0
INFO - Short Average Trade       :  0.0
INFO - Short Avg Winner Trade    :  0.0
INFO - Short Avg Loser  Trade    :  0.0
INFO - Short Max Winner Trade    :  0.0
INFO - Short Max Loser  Trade    :  0.0
INFO - >-------------------------------- ------------- ---------------------------------<
```

This strategy makes around 52% on IBM & Apple, Long only, between 1/1/2008 and 31/12/2010 with an initial capital of $20k and fixed $5k per trade.

Setting Commission Costs

In order to assess the strategy in a realistic way, it is necessary to consider the costs of commission, this can be set by accessing the PaperBroker:

```
	private final IBroker broker = new PaperBroker(account);
	{
		broker.setBrokerCommissions(SecurityType.STK, 10.0);
	}
```

Sets $10.0 per execution.

Setting Slippage

Slippage is the difference between estimated transaction costs and the amount actually paid, it can be set by accessing the PaperBroker:

```
	private final IBroker broker = new PaperBroker(account);
	{
		broker.setSlippage(0.5);
	}
```

Trade (execute) a Strategy

Switching from Testing to real Execution is quite simple.

Once you have validated your strategy, you can switch to "live mode" by replacing this components:

- Broker
- Account
- MarketDataFeed

Referring to the example saw before, we just need to switch from PaperBroker/Account to real Broker/Account and change the Yahoo data provider to a real time data provider.

Suppose we are using InteractiveBrokers:

```
private final IAccount account = new IBAccount();

private final InteractiveBrokersAdapter interactiveBrokersAdapter = new InteractiveBrokersAdapter();

private final IBroker broker = new IBBroker(account,interactiveBrokersAdapter);

private final IBMarketDataFeed marketDataFeed = new IBMarketDataFeed(interactiveBrokersAdapter);
```

Then, we should say to InteractiveBrokers to feed us with daily data or we can just collect intraday quotes thought our CEP engine and filter out the daily value, this is an aspect we cannot cover in this paragraph.

Appendix

All source code can be found online at the www.thebonnotgang.com website.

For any doubts or support request please feel free to contact us both via community forums or by email at info@thebonnotgang.com

Skeleton Strategy Code

```
package com.tbg.TradingSystem.tutorial0;

import com.tbg.adapter.bogus.marketdatafeed.BogusMarketDataFeed;
import com.tbg.adapter.paper.account.PaperAccount;
import com.tbg.adapter.paper.broker.PaperBroker;
import com.tbg.core.model.broker.IBroker;
import com.tbg.core.model.strategy.IStrategy;
import com.tbg.core.model.types.Currency;
import com.tbg.core.model.types.Messages;
import com.tbg.core.model.types.SecurityType;
import com.tbg.strategy.TradingSystem;
import com.tbg.strategy.utils.LoadSecurities;

/**
 * Skeleton Strategy <br>
 */
public class MySkelStrategy extends TradingSystem implements IStrategy {

	private final PaperAccount account = new PaperAccount();
	private final IBroker broker = new PaperBroker(account);
	private final BogusMarketDataFeed marketDataFeed = new BogusMarketDataFeed();

	public MySkelStrategy(){
		setTradingSystemName("My Skeleton Strategy");
		setTradingSystemDescription("Use this strategy to build something more unique!");
		setBroker(broker);
		setMarketDataFeed(marketDataFeed);
		subscribeSecurities(new LoadSecurities(SecurityType.STK, "SMART", Currency.USD,
							"XOM,WMT,AAPL").getSecurities());
	}

	@Override
	public void onStart() {
		// On Strategy starts
	}

	@Override
	public void onStop() {
		// On Strategy stops
	}

	@Override
	public void onEvent(Object event) {
		// On MarketEvent
		log.info(event);
	}

	@Override
	public void onError(Messages msg) {
		// On Error occurs
	}

	public static void main(String[] args) {
		new MySkelStrategy().start();
	}
}
```

Simple Moving Averages Crossover Strategy Code

```
/**
 * tbg-Quant examples package
 */
package com.tbg.TradingSystem.tutorial1;

import com.tbg.adapter.paper.account.PaperAccount;
import com.tbg.adapter.paper.broker.PaperBroker;
import com.tbg.adapter.yahoo.marketdatafeed.YahooMarketDataFeed;
import com.tbg.core.model.Order;
import com.tbg.core.model.broker.IBroker;
import com.tbg.core.model.report.IReportService;
import com.tbg.core.model.strategy.IStrategy;
import com.tbg.core.model.types.Currency;
import com.tbg.core.model.types.Messages;
import com.tbg.core.model.types.OrderSide;
import com.tbg.core.model.types.OrderType;
import com.tbg.core.model.types.ReportType;
import com.tbg.core.model.types.SecurityType;
import com.tbg.core.model.types.TrendSide;
import com.tbg.core.model.types.event.CandleEvent;
import com.tbg.indicator.SMA;
import com.tbg.service.report.TextReportService;
import com.tbg.strategy.TradingSystem;
import com.tbg.strategy.utils.LoadSecurities;

/**
 * Tutorial1 - Simple Moving Averages cross strategy <br>
 * <br>
 * Check out www.thebonnotgang.com online support.
 * <br>
 */
public class Tutorial1 extends TradingSystem implements IStrategy{

        // set the PaperAccount, $2000 initial capital
        private final PaperAccount account = new PaperAccount(20000, Currency.USD);
        private final IBroker broker = new PaperBroker(account);
        {
                broker.setBrokerCommissions(SecurityType.STK, 10.0);
                broker.setSlippage(0.5);
        }
        private final YahooMarketDataFeed marketDataFeed = new YahooMarketDataFeed();
        {
                /**
                 * Sets the historical daily data from Yahoo
                 * From : DD , MM , YYYY
                 * To   : DD , MM , YYYY
                 * Yahoo provides DAILY, WEEKLY and MONTHLY
                 */
                marketDataFeed.setYahooParameters("01", "01", "2008",
                                                  "31", "12", "2010",
                                                  marketDataFeed.YAHOO_DAILY);
        }

        private final IReportService reportService = new TextReportService();
        {
                reportService.setReportType(ReportType.OUTPUT_ONLY);
        }


        public Tutorial1() {
                setTradingSystemName("Tutorial1");
                setTradingSystemDescription("Simple SMA cross");
                setBroker(broker);
                setReportService(reportService);
                setMarketDataFeed(marketDataFeed);
                subscribeSecurities(new LoadSecurities(SecurityType.STK, "SMART", Currency.USD,
                                                       "IBM,AAPL").getSecurities());
                setMinimunSystemPeriods(100);
        }
```

```
	@Override
	public void onStart() {
		log.info("START");
	}

	@Override
	public void onStop() {
		log.info("STOP");
		closeAllOpenPositions();
		accountReport();
	}


	SMA sma1 = new SMA(60);
	SMA sma2 = new SMA(100);
	@Override
	public void onEvent(Object event) {
		//log.info(event);

		CandleEvent ce = (CandleEvent) event;
		String symbol  = ce.getSymbol();

		sma1.add(symbol, ce.getClosePrice());
		sma2.add(symbol, ce.getClosePrice());

		  // be sure we reached the minimun events
		if (getSystemActivation(symbol)){
			if (sma1.getValue(symbol)>sma2.getValue(symbol))
				trendTracker.setTrendSide(symbol,TrendSide.UP);
			else
				if (sma1.getValue(symbol)<sma2.getValue(symbol))
					trendTracker.setTrendSide(symbol,TrendSide.DOWN);
				else
					trendTracker.setTrendSide(symbol,TrendSide.FLAT);


		if (trendTracker.getTrendSide(symbol)==TrendSide.UP){
			if (positionTracker.getStatusForSymbol(symbol)==PositionTracker.NON_EXISTENT){
				// Open position for symbol
				Order order = new Order();
				order.setSecurity(getSecurityBySymbol(symbol));
				order.setOrderSide(OrderSide.BUY);
				order.setOrderType(OrderType.MARKET);
				order.setQuantity(getSharesFor(5000, ce.getClosePrice()));

				broker.sendOrder(order);
			}
		}else{
			if (positionTracker.getStatusForSymbol(symbol)==PositionTracker.POSITION_EXISTENT){
					closePositionFor(symbol);
				}

			}
		}// end system activated


	}

	@Override
	public void onError(Messages msg) {
		// TODO Auto-generated method stub
	}

	public static void main(String[] args) {
		new Tutorial1().start();
	}
}
```