MultiOpt

multiopt.net

Contents

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Licenses are not transferrable to other TradeStation Customer IDs.

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MultiOpt

MultiOpt is a strategy development automation/walkforward testing and data analysis tool. These two objectives are at the core of the MultiOpt project.

Developing strategies is a very personalized experience. I have a TON of strategies that I will never trade. Some I have received from other SF members and some I have developed. While they are all good and successful strategies, they, for a variety of reasons, do not fit my trading style. I have learned to honor my risk/comfort level. I have learned what level of my finances I am willing to commit and what level I am not. All this means that the strategies need to be in line with my own personal proclivities.

MultiOpt is an invaluable tool to help design, develop and test strategies that work for ***you***.

Strategy Development and Walkforward Testing

Strategy development and walkforward testing is a time consuming process. Taking a strategy idea and testing it against multiple markets or time frames and performing walkforwards on each of them can take hours of trial and error, hit and miss. MultiOpt streamlines this process.

Data Analysis

MultiOpt provides many metrics for data analysis. In addition to wanting to automate strategy development, I also wrote MultiOpt to be an analysis tool. With it, you can construct tests using MultiOpt and spreadsheet programs, such as Excel, to analyze what works, or does not work, concerning the many different analysis metrics used today in strategy development.

Phases of Operation

MultiOpt has three primary phases of operation:

- Phase 1: Preliminary analysis
- Phase 2: Strategy Optimization
- Phase 3: Walkforward analysis

The preliminary analysis phase is considered a "limited feasibility study". It is meant to quickly identify potential market candidates without incurring the more lengthy optimization process of Phase 2. Phase 2 will optimize any potential candidates identified in Phase 1. Phase 3 will then perform a walkforward process using the optimization results from Phase 2.

The genesis of this project rose out of my own trading experience and Kevin Davey's workshop on strategy development. Therefore you will hear me mention some of these concepts throughout this user manual. For more information on his workshop, please visit his website at https://kjtradingsystems.com/strategy-workshop.html.

This document will detail the use of MultiOpt. It is not, however, a tutorial for strategy development techniques or optimization and walkforward processes. Information on those subjects can be found in workshops, on the web, in books and many other resources.

To get started on those concepts, see the following:

- Strategy Development and Testing: see Kevin Davey's workshop mentioned above.
- Strategy Optimization: see TradeStation's help manual at http://help.tradestation.com/09_01/tradestationhelp/optimize/about_strategy_optimization.htm
- Walkforward Process: see this Wikipedia article: https://en.wikipedia.org/wiki/Walk_forward_optimization

What Does It Cost?

The cost of MultiOpt is a one-time license fee of $450. This includes one year of user support and software updates. You may try MultiOpt for a 14-day trial period. Add-on's, when available, are covered under their own licenses and separate costs.

MultiOpt can be purchased by direct wire (email admin@multiopt.net for details), or PayPal using the following link: https://www.paypal.me/multiopt/450

After sending payment, please email admin@multiopt.net the following information:

- TradeStation Customer ID (found on the TradeStation Help->About screen and used for your MultiOpt registration)
- Sign up for MultiOpt's mailing list for new releases and updates at http://eepurl.com/hdevH5

If you have multiple TS customer IDs and would like to run MultiOpt on each, you can purchase additional licenses at a 20% discount price of $360 per additional TS customer number. These Customer ID's must be under the same user/organization name. Transferring existing licenses to another Customer ID is not possible.

If you have multiple TS logins under the same TS customer ID, you may install MultiOpt under the same license on multiple machines without purchasing additional licenses.

International Users: PayPal is expensive on both sending and receiving side for international transactions. If you would like to lessen these fees, another alternative is to send a wire transfer either locally from your own bank or using a service such as TransferWise. If you would like to wire payment rather than using PayPal, please contact admin@multiopt.net for more information.

If you have any questions, please let me know. Discussions of MultiOpt can be found on the Strategy Factory Forum at http://strategyfactory.boardhost.com/viewforum.php?id=22.

Downloading the Latest Release

The latest release can be downloaded from the following link: http://bit.ly/MultiOptRelease

Requirements

TradeStation 9.5, 10 or higher

MultiOpt uses TradeStation's optimization API and will therefore only run under TradeStation 9.5 or higher.

Suggested: Multi-Core Processor, Intel i7 or greater

MultiOpt can be CPU intensive, especially if you perform optimizations on many markets and smaller time frames (such as 60, 30, or less minute time frames). Under these situations it could take hours to run one simulation. While I have run MultiOpt on my aging laptop, I suggest using a moderately to strong CPU for comprehensive runs.

Suggested: Two TradeStation data logins

MultiOpt is CPU intensive as well as demanding on TradeStation itself. I, personally, do not run MultiOpt on the same system that trades live. It is possible, but not suggested as I would not want to do anything to compromise the stability of the live system.

You can get an additional data login from TradeStation and use delayed data for that login. Delayed data is mostly free from TradeStation. I pay around $8/month total for various delayed data feeds.

If you get a second data login from TradeStation, be sure to have them assign your current Customer ID to the login. This is very important so that you can run MultiOpt under either login. Otherwise you would need to purchase an addition MultiOpt license for the additional Customer ID.

Installing or Updating MultiOpt

You will need Administrator access in order to install or update MultiOpt since it copies DLL files to the TradeStation program folder.

Installation is a two-step process that must be performed whenever you install a new release of MultiOpt:

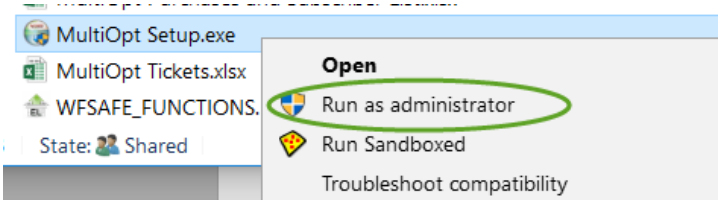
1. Run the self-installer “MultiOpt Setup.exe”
2. Start TradeStation and import “MULTIOPT APP.ELD” and “MULTIOPT EXAMPLE AND USER FUNCTIONS.ELD”

This will create and/or update the TradingApp MultiOpt in TradeStation. More detailed instructions follow:

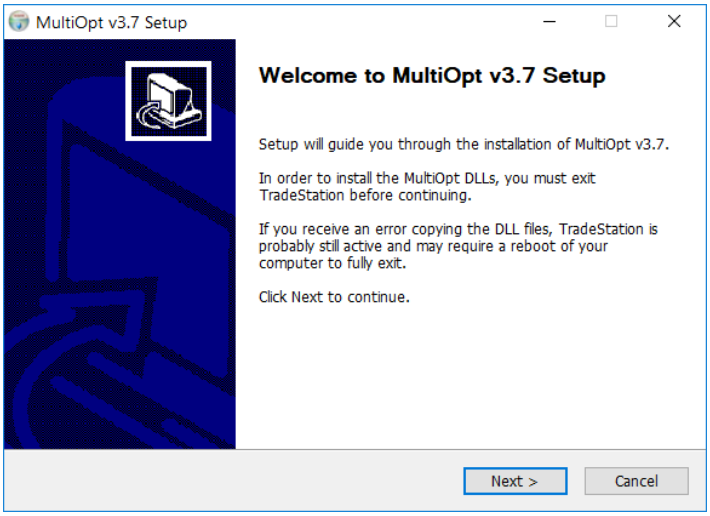
Run “MultiOpt Setup.exe”

Exit TradeStation if it is running. Then run “MultiOpt Setup.exe”

You will need to run this from an account that has administrator rights, or run the installer with those rights enabled by right-clicking on the installer and selected “Run as administrator”:



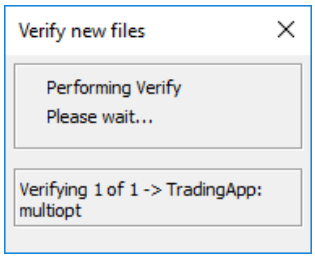
You will be presented with an installation screen. Simply follow the prompts to install.

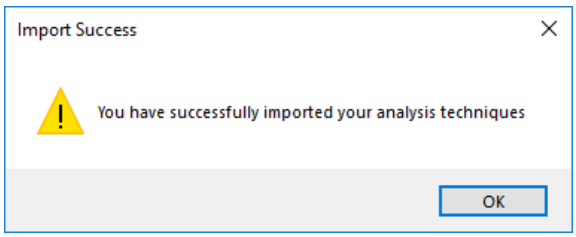


Import TradeStation ELDs

After MultiOpt DLLs are installed above, import “MULTIOPT APP.ELD” and “MULTIOPT USER FUNCTIONS.ELD” into TradeStation. These will add the MultiOpt TradingApp as well as supporting functions to TradeStation.

When you import the ELD’s, you should see the following pop-up messages from TradeStation:





MultiOpt will be available in TradeStation’s TradingApp list.

Checking MultiOpt Version Number

The version of MultiOpt can be found on the Settings->General screen. It is also written to the log window when an operation is performed. In this way you can verify the version of MultiOpt installed on your system.

Video Tutorials

The Basics From Start To Finish

I have created a two part video tutorial series on the use of MultiOpt. These two tutorials take a strategy step-by-step through the development process using MultiOpt. Part I covers the setup of a MultiOpt strategy and the first two phases of the development process: preliminary optimization (Phase 1) and full optimization (Phase 2). Part II covers the walkforward process and final analysis reports that help identify the markets and time frames that have the most potential for real-time trading.

These tutorials are much more comprehensive than what can be written in this user manual. They can be downloaded using the following links:

Part I: https://ln2.sync.com/dl/62caf72b0/ffb5pkkg-4wi72xg4-w7hzxyu4-83a6cxnd

Part II: https://ln2.sync.com/dl/201e72230/byqrta5c-eddmuy5p-iwsnttbp-gmrc7q57

How To Reoptimize Strategies Using MultiOpt

This tutorial takes you step-by-step process of how to set up MultiOpt to re-optimize your strategies using one of my own strategies that has been trading live since 2018.

Download here: https://ln2.sync.com/dl/96a107040/2zzctthd-6jrjeecy-itqk2y5t-f8q7gsga

MultiOpt Webinar Discussion with Kevin and Dave

Kevin hosted a webinar with me as a guest speaker. Kevin discusses ways he uses MultiOpt and I go through a quick example of implementing a strategy idea I found the morning before in Stocks & Commodities magazine.

Download here: https://ln2.sync.com/dl/a535eeb00/xb4igwny-ujar3p4b-tkfkkb6q-m42ck2jn

Why not use TradeStation's Walkforward Optimizer?

I wish that I could use TradeStation's Walkforward Optimizer since it comes packages with the platform, but there are several short-comings and issues that do not make this possible for me.

Cannot Perform Walkforward on Multiple Symbols and Timeframes

Being able to test a strategy across multiple symbols and timeframes has become extremely important in my own strategy development. TradeStation's WFO cannot do this.

Design Issues and Problems

Unfortunately there are several issues with TradeStation's built-in walkforward optimizer that make it unsuitable for real-time trading because of the way it handles walkforward in/out distributions. This has unintended (and unfavorable) consequences to re-optimizations for real-time trading.

I pointed out one of these issues back in 2015:

https://community.tradestation.com/Discussions/Topic.aspx?Topic_ID=141281

TradeStation's response was that they added the "partial" last walkforward segment to the complete last walkforward segment so that the partial segment would be "statistically significant". Unless you are doing some kind of research, this does not matter. It's not important.

What is important is that you trade that last partial walkforward period with the correct parameters. Arithmetrick proposed a workaround to this issue at the end of that thread, but it is cumbersome and time consuming to make TradeStation's Walkforward Optimizer produce the correct results. His final comment was "P.S. It would be nice if this were correctly handled within the TS WFO."

I agree. It's now been 5 years since that post.

Here is a list of other reported issues and bugs with no resolution:

https://community.tradestation.com/Discussions/Topic.aspx?Topic_ID=173038

https://community.tradestation.com/Discussions/Topic.aspx?Topic_ID=172896

https://community.tradestation.com/Discussions/Topic.aspx?Topic_ID=135168

https://community.tradestation.com/Discussions/Topic.aspx?Topic_ID=181581

Does Not Generate EasyLanguage Code

TradeStation's WFO does not generate the EasyLanguage code of optimized parameter ranges. At best you will need to copy their in-sample and out-of-sample charts to a spreadsheet and do this yourself.

It's Just Plain Complicated

Generating the optimization results, setting up the walkforward environment and, especially, managing the walkforward process during real-time trading (which doesn't work anyway, see above design flaws), is very cumbersome and confusing in TradeStation. This process is complicated enough and I wanted something that I could more easily work with and manage.

MultiOpt Uses and Cautions

Data Mining

While a data mining tool such as MultiOpt can save a considerable amount of time when testing strategy ideas across several markets and time frames, it can also be used to over-fit a strategy to any one market or time

frame. This is always the danger when using any data mining tool. While the results look like you may have found an "edge", this could also simply be random luck. For that reason, consider ways in which you can reduce data mining bias.

A few possibilities are:

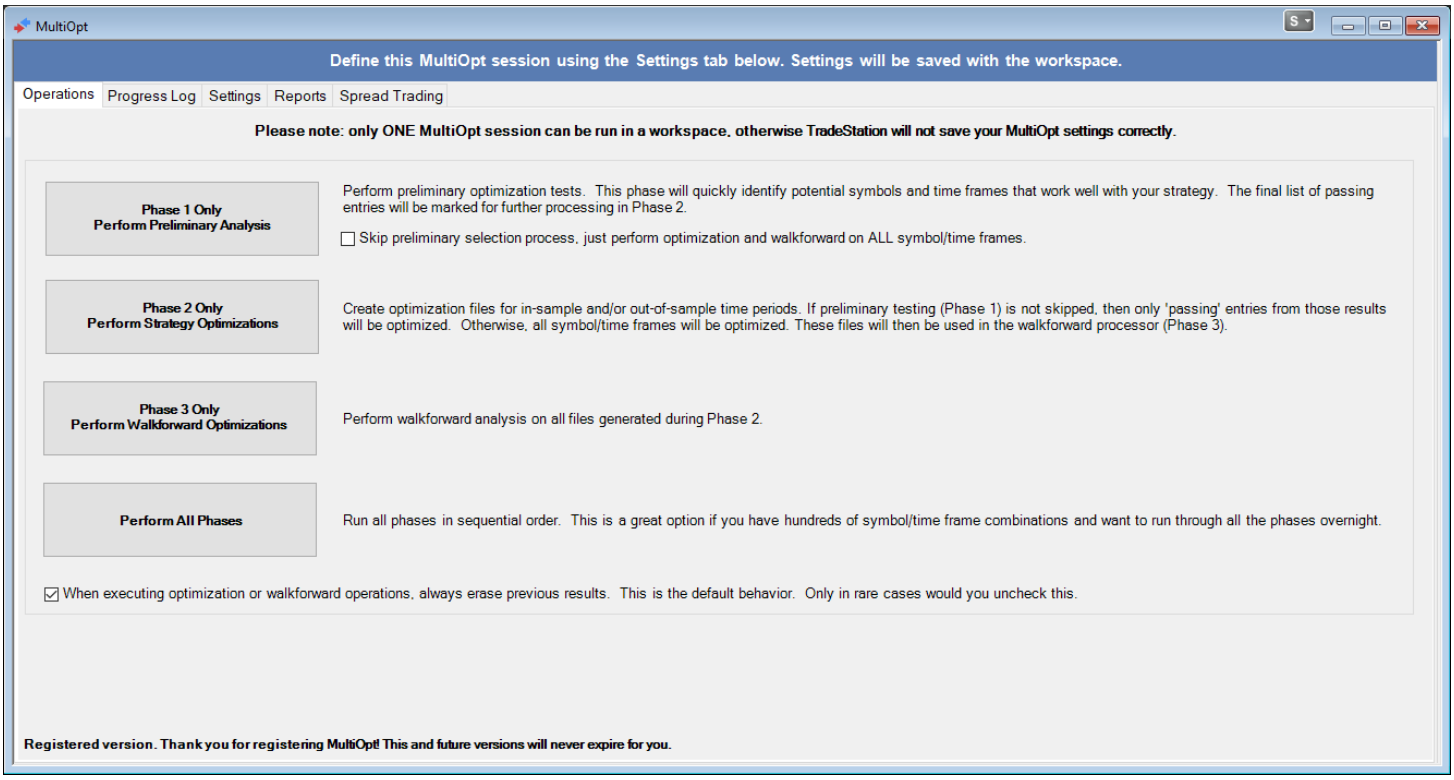
- Be sure to follow the Strategy Factory Workshop guidelines or similar as you develop the strategy.
- If you find a good strategy symbol/time frame match, don't make any more changes to the strategy or optimized parameter ranges so you avoid over-optimizing. Use it as-is. In other words, once you run it through MultiOpt and find a symbol/time frame match, that's it. This is a one-shot deal.
- Look for good performance across several in/out walkforward periods.
- Look for fair to good performance across several markets and time frames (as is done in Phase 3 of MultiOpt operation). While each market has its own character, one indication of strategy robustness may be good performance across several markets.

Suggestions of Use

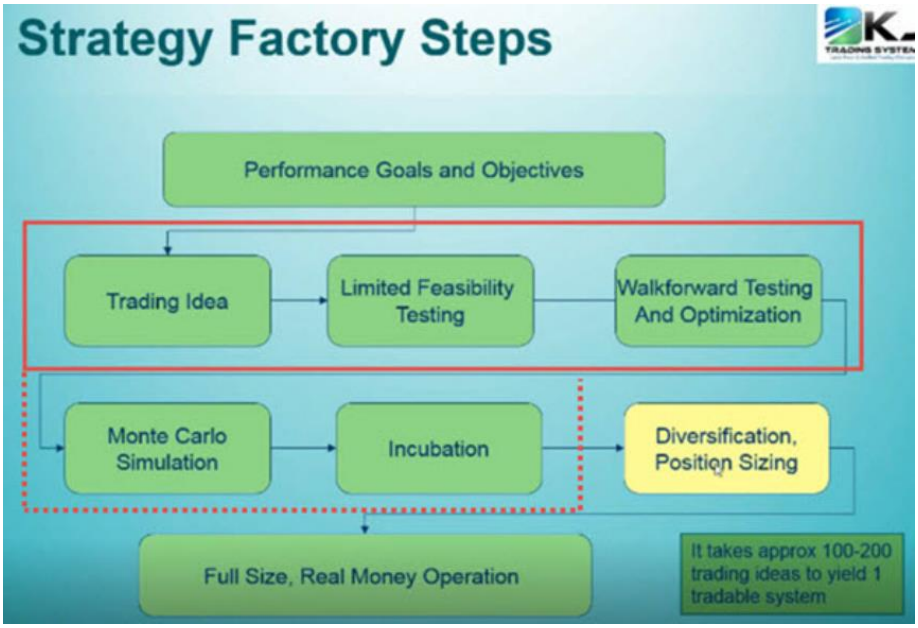
- Take an existing strategy that you know has been profitable and run it through MultiOpt on various markets and time frames. Give some consideration to the strategy input parameter selection as the ranges for parameters on one time frame may not be applicable to the parameter ranges of another.
- Take an idea you want to test and run it across various symbols and time frames. Consider all the cautions above as you do so.
- Share your own ideas and suggestions for use in the Strategy Factory Forum at the following thread: https://strategyfactory.boardhost.com/viewtopic.php?id=335

Operations

MultiOpt has three modes of operation:



These correspond to Kevin Davey's following Strategy Factory Workshop steps. You start with a strategy idea and configure MultiOpt for your test run ("Trading Idea" step). Phase 1 is the "Limited Feasibility Testing" step. Phase 2 and 3 are the "Walkforward Testing And Optimization" step.



MultiOpt also has a built-in Monte Carlo processor and Incubation simulation mode. These two inclusions give you the ability to automatically perform those strategy factory workshop withint MultiOpt without having to switch to an Excel spreadsheet for Monte Carlo or 6 months of real-time incubation. However, to truly simulate incubation you must be

honest and run your strategy only *once* as though incubation was real-time as well as confirm the Monte Carlo results in Excel. For those who have taken Kevin Davey's workshop and are using his Monte Carlo spreadsheet, MultiOpt's Monte Carlo results includes daily drawdowns, whereas Kevin's spreadsheet MC does not. This makes MultiOpt's MC much less, than Kevin's 2.0 requirement. So test anything above 1.0 in MultiOpt to see if this results in a 2.0+ MC in Kevin's spreadsheet.

Phase 1: Perform Preliminary Optimization (Limited Feasibility Testing)

A preliminary optimization will analyze a strategy applied to every symbol and time frame defined.

Normally you would define a random two year window of time to test.

Optimizations are "exhaustive". This means that an optimization will be performed on every parameter combination define (called "iterations"). For this reason, optimizations can be time consuming if you have many iterations. Since the preliminary phase is run on a smaller time period, the optimizations performed will not take as long as the full scale optimization in Phase 2. This helps identify a subset of potential candidates rather than unnecessarily run full length optimizations on all defined markets and time frames.

A report will be generated with the results and stored in the project folder.

This output file is the *input* file for Phase 2. The preliminary mode will pre-select any strategy based on the selection model defined (see the tab *Settings->PrelimOpt*) for full scale optimization later (Phase 2). It does this by placing an asterisk in the first column of each strategy symbol/time frame combination in the list. In other words, if there is an asterisk in the first column, that item will be selected for full optimization and walkforward analysis.

You can manually select or deselect items targeted for full optimization by clicking in the "Selection/Passing" column.

Passing	Data1 Symbol	Data1 Chart Interval	Session	Begin Date	End Date	Total Years	Total Iters	Total Iterations Satisfying Selection Model	Iterations Satisfying Selection Model (%)	Total Iterations Profitable (> $0)	Iterations Profitable (%)	Iteration Highest Net Profit ($)	Iteration Lowest Net Profit ($)
*	@ES	Daily	Regular Session	6/1/2016	6/1/2018	2	792	792	100%	792	100%	$21,555	$768
	@GC	Daily	Regular Session	6/1/2016	6/1/2018	2	792	0	0%	0	0%	$0	$0
	@CL	Daily	Regular Session	6/1/2016	6/1/2018	2	792	0	0%	0	0%	$0	$0
	@PL	Daily	Regular Session	6/1/2016	6/1/2018	2	792	0	0%	0	0%	$0	$0
*	@ES	360min	Regular Session	6/1/2016	6/1/2018	2	792	773	98%	773	98%	$24,860	($8,040)
*	@GC	360min	Regular Session	6/1/2016	6/1/2018	2	792	618	78%	618	78%	$35,243	($24,654)
*	@CL	360min	Regular Session	6/1/2016	6/1/2018	2	792	756	95%	756	95%	$29,546	($5,035)
	@PL	360min	Regular Session	6/1/2016	6/1/2018	2	792	90	11%	90	11%	$6,862	($21,229)
*	@ES	240min	Regular Session	6/1/2016	6/1/2018	2	792	705	89%	705	89%	$21,740	($16,465)
*	@GC	240min	Regular Session	6/1/2016	6/1/2018	2	792	486	61%	486	61%	$30,503	($42,532)
*	@CL	240min	Regular Session	6/1/2016	6/1/2018	2	792	777	98%	777	98%	$29,666	($5,314)
	@PL	240min	Regular Session	6/1/2016	6/1/2018	2	792	261	33%	261	33%	$12,607	($22,799)
	@ES	Daily	Regular Session	1/1/2007	5/1/2020	13	792	370	47%	370	47%	$30,460	($47,498)
*	@ES	360min	Regular Session	1/1/2007	5/1/2020	13	792	411	52%	411	52%	$46,198	($46,960)
*	@GC	360min	Regular Session	1/1/2007	5/1/2020	13	792	788	99%	788	99%	$134,657	($16,541)
*	@CL	360min	Regular Session	1/1/2007	5/1/2020	13	792	759	96%	759	96%	$262,792	($21,075)

If you have checked "Skip preliminary selection process" on the Operations screen, then a full optimization will be performed on EVERY market and time frame defined. If this is unchecked, then only candidates that pass the criteria tests of Phase 1 will be selected for optimization.

Phase 2: Optimization

This phase performs the exhaustive optimizations on every market and time frame for the strategy. The optimization files are stored in the "Optimization Files" project folder.

Phase 3: Walkforward

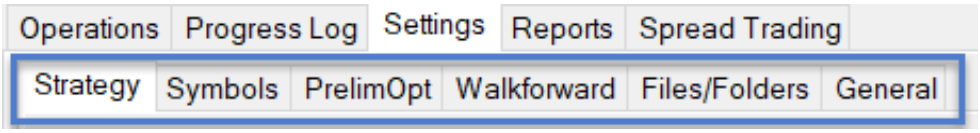
This phase performs the walkforward analysis. All files created by the walkforward process are stored in the "Walkforward Files" project folder.

Walkforward testing can be performed on either one time period alone or include an incubation time period. Please see Incubation section below for more information on setting up walkforward time periods.

The walkforward performance metrics and graphs are displayed on the *Reports->Walkforward Metrics* tab for every market/time frame and walkforward in/out period. These results can be used as the basis for analyzing performance and determining what markets and time frames warrant further investigation for your strategy. One way of determining the strategy's viability, see the report tab *Reports->Walkforward In/Out Periods Analysis.*

MultiOpt Strategy Setup and Project Configuration

A MultiOpt project is configured using the various "Settings" tabs.



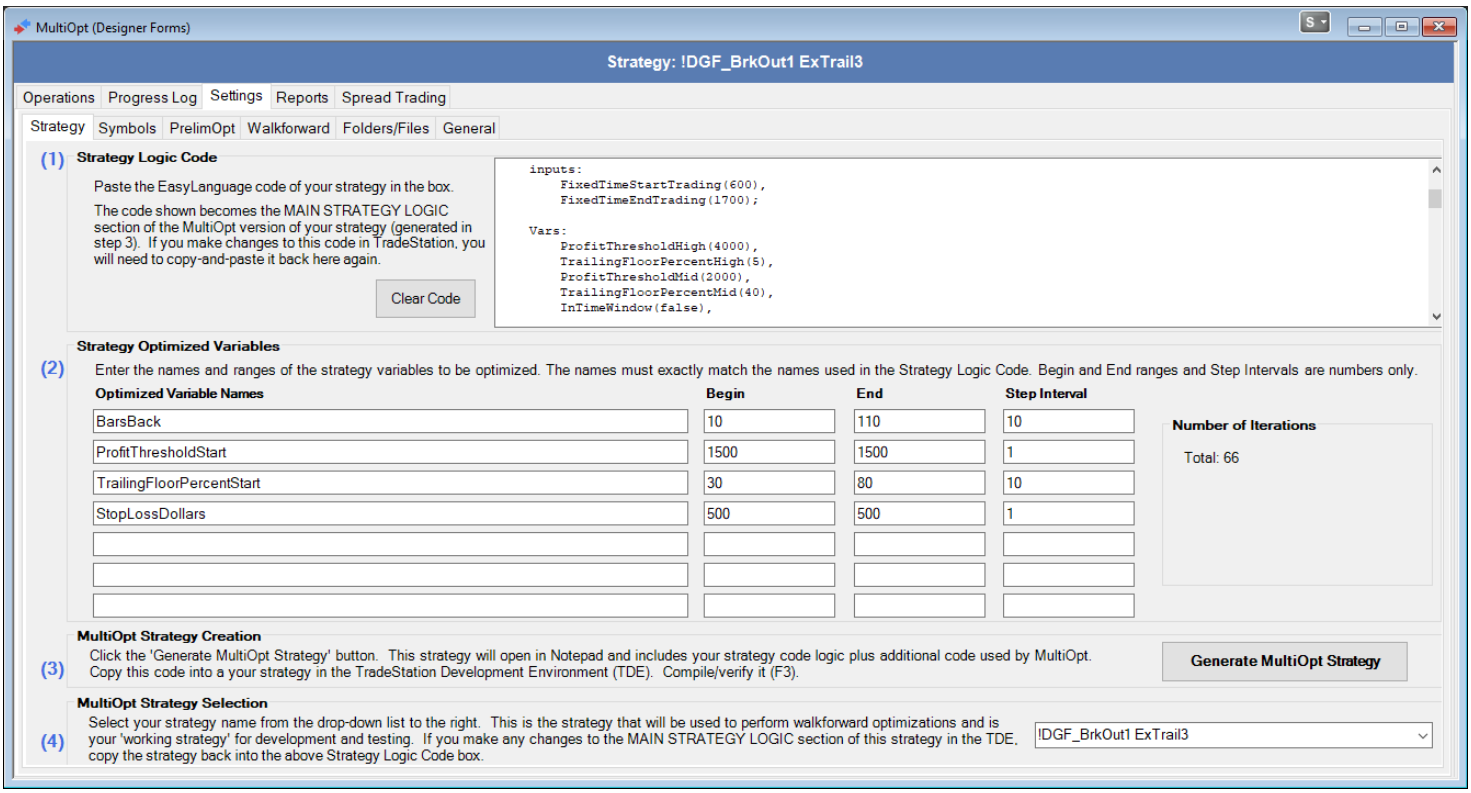
Strategy Setup

The easiest way to create a MultiOpt strategy is to let MultiOpt do it for you.

A "MultiOpt strategy" uses your strategy logic code and "wraps" special code around it so that it can be used in MultiOpt's optimization and walkforward testing.

You will first create a strategy in the TradeStation Development Environment/Editor (TDE). Simply create your strategy idea and verify/compile (F3) it in the TDE. It's a good idea at this point to test it on a chart to make sure that it is performing the way you expect it.

Then, simply follow the steps on the Settings->Strategy screen to create the *MultiOpt version of your strategy*:



First, create your initial strategy in TDE and test to make sure it is working the way you expect it. Then:

Step 1: Copy your strategy from TDE and paste it into the Strategy Logic Code box.

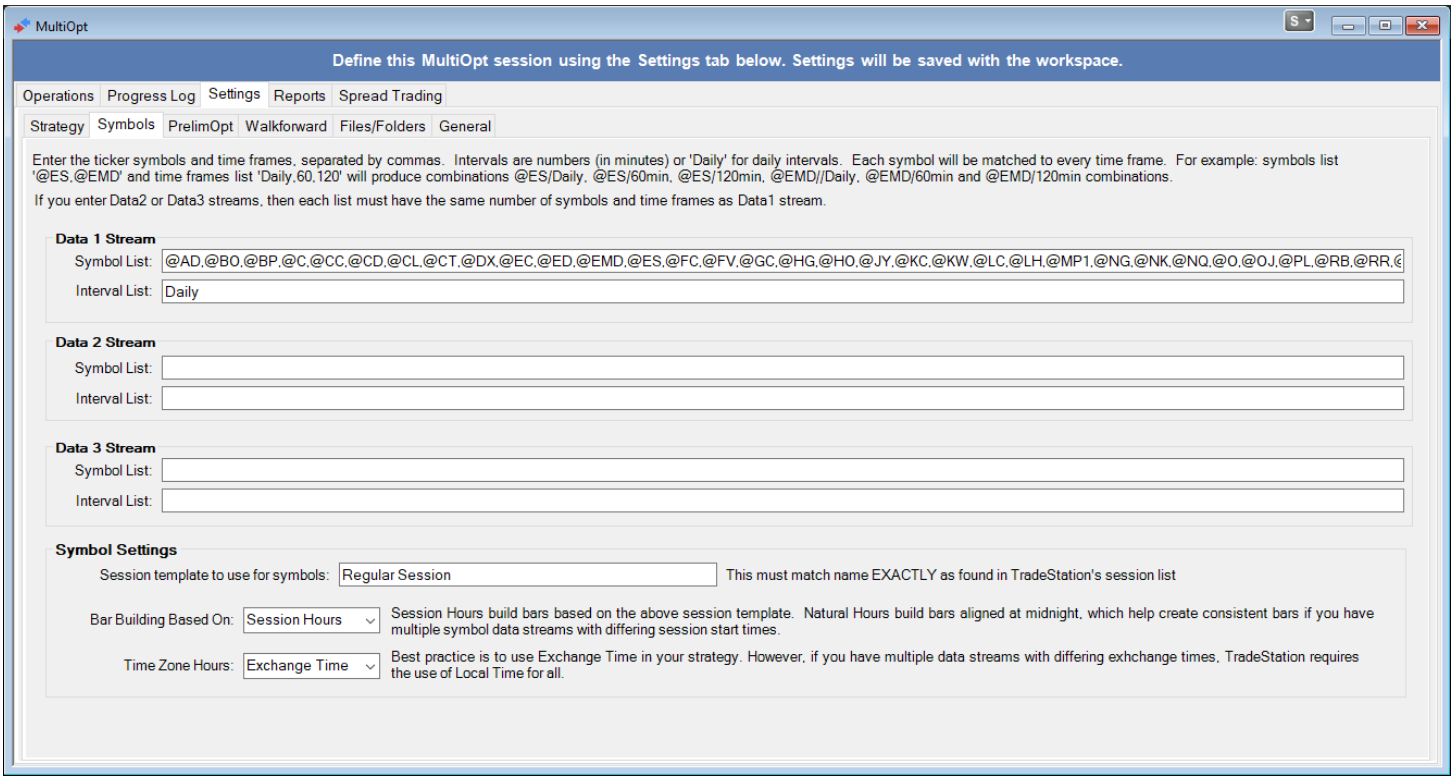
Step 2: Define your optimized variables. These variable names must be typed EXACTLY as they appear in your strategy code.

Step 3: Click the "Generate MultiOpt Strategy" button. MultiOpt will open the strategy code in Notepad. Copy and paste this back into the strategy (or create a new one) in the TDE. Verify/Compile it (F3).

Step 4: Return to MultiOpt and select that strategy from the list.

That's it! Now review the other settings screens to make any other configuration changes specific to your strategy.

Market Symbols



This screen configures the symbols and time frames used to test the strategy.

Symbol List

The **Symbol List** is a comma-separated list of symbols to analyze. For example, an extensive analysis across many markets could be:

@AD,@BO,@BP,@C,@CD,@CL,@DX,@E7,@EC,@ED,@EMD,@ES,@FC,@FV,@GC,@HG,@HO,@J7,@JY,@KW,@LC,@LH,@M2K,@MES,@MNQ,@MP1,@MYM,@NG,@NK,@NQ,@O,@PL,@QM,@QN,@RB,@RR,@RTY,@S,@SF,@SI,@SM,@TU,@TY,@UB,@US,@W,@YG,@YI,@YM

If there are no Data2 or Data3 streams, then leave them blank. Otherwise, they must have the same number of symbols as defined in Data1. For example, If you have an inter-market strategy that you want to test on index futures and Data2 is always going to be fixed using the symbol $UTY, then you would define Data1 and Data2 as follows:

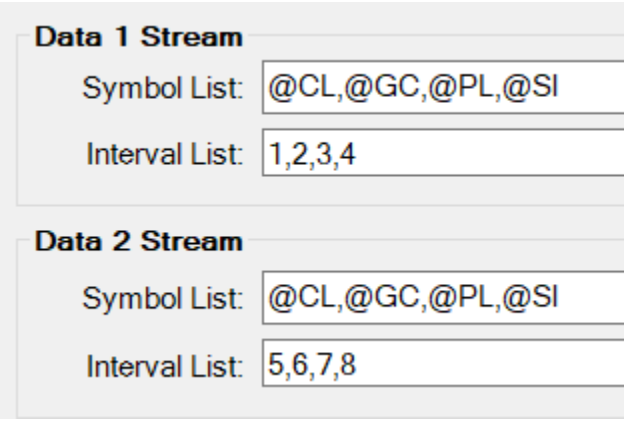
Data1: @ES,@EMD,@NQ,@RTY,@YM
Data2: $UTY, $UTY, $UTY, $UTY, $UTY

Interval List

The **Interval List** is a list of comma-separated time frame intervals, such as "60,240", where N will equal number of minutes for intraday charts. You can also use "Daily", "Weekly" or "Monthly" to indicate daily charts, such as "Daily,60,240". This will create three time frames for each symbol (daily, 60 minute, and 240 minute).

The interval lists for Data2 and Data3 (if used) must contain the same number of intervals as Data1.

To make this easier to see, consider the following data1/data2 example. data1 intervals are set to 1, 2, 3, 4 and the data2 interval list to 5, 6, 7, 8.



This creates the following combinations:

- CL-1min + CL-5min
- GC-1min + GC-5min
- PL-1min + PL-5min
- SI-1min + SI-5min

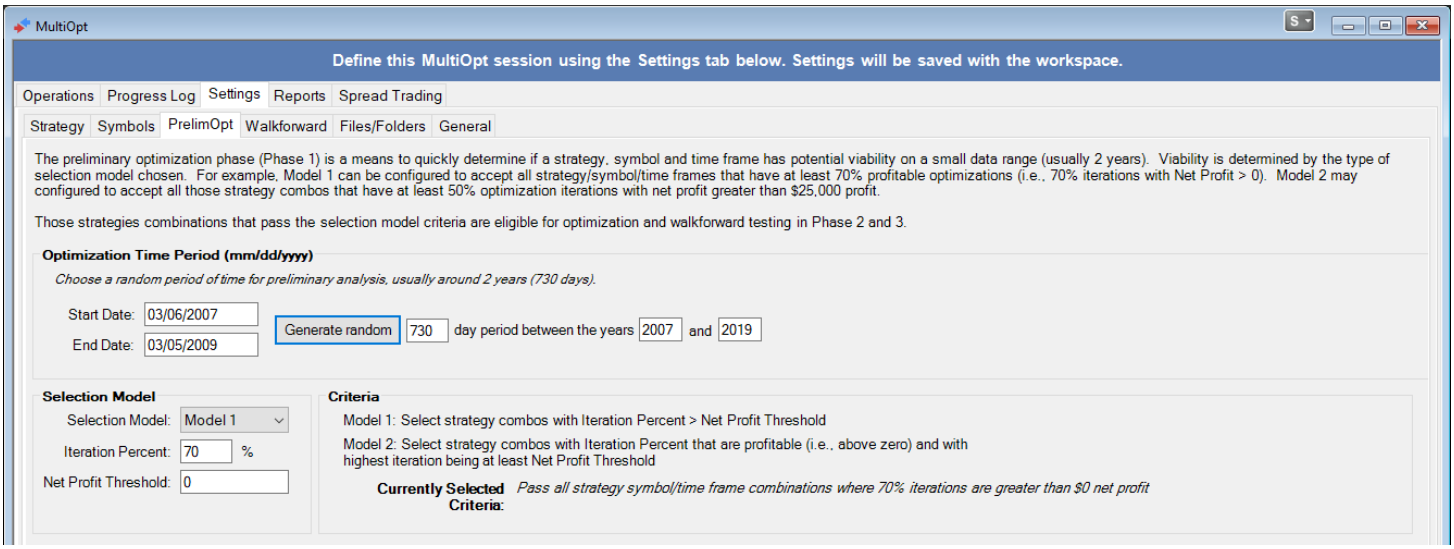
- CL-2min + CL-6min
- GC-2min + GC-6min
- PL-2min + PL-6min
- SI-2min + SI-6min

- CL-3min + CL-7min
- GC-3min + GC-7min
- PL-3min + PL-7min
- SI-3min + SI-7min

- CL-4min + CL-8min
- GC-4min + GC-8min
- PL-4min + PL-8min
- SI-4min + SI-8min

Every symbol is run against every interval set for data1/data2/data3. The first interval set in this example is 1,5 for every symbol, the next set is 2,6, etc.

PrelimOpt



This screen configures Phase 1, the limited feasibility testing step.

If "Skip preliminary selection process" is selected/checked on the Operations screen, then a full optimization will be performed on EVERY market and time frame defined. If this is unchecked, then only candidates that pass the criteria tests of Phase 1 will be selected for optimization. Enabling this Preliminary Testing phase is a huge time saver since MultiOpt will only optimize potential candidates rather than EVERY possible market and time frame defined.

Time Period

Select the time period that you want to use for this preliminary optimization. MultOpt will optimize all possible market and time frame combinations on this time period and select those that pass the selection criterion defined for the full walkforward time period defined on the Settings->Walkforward screen.

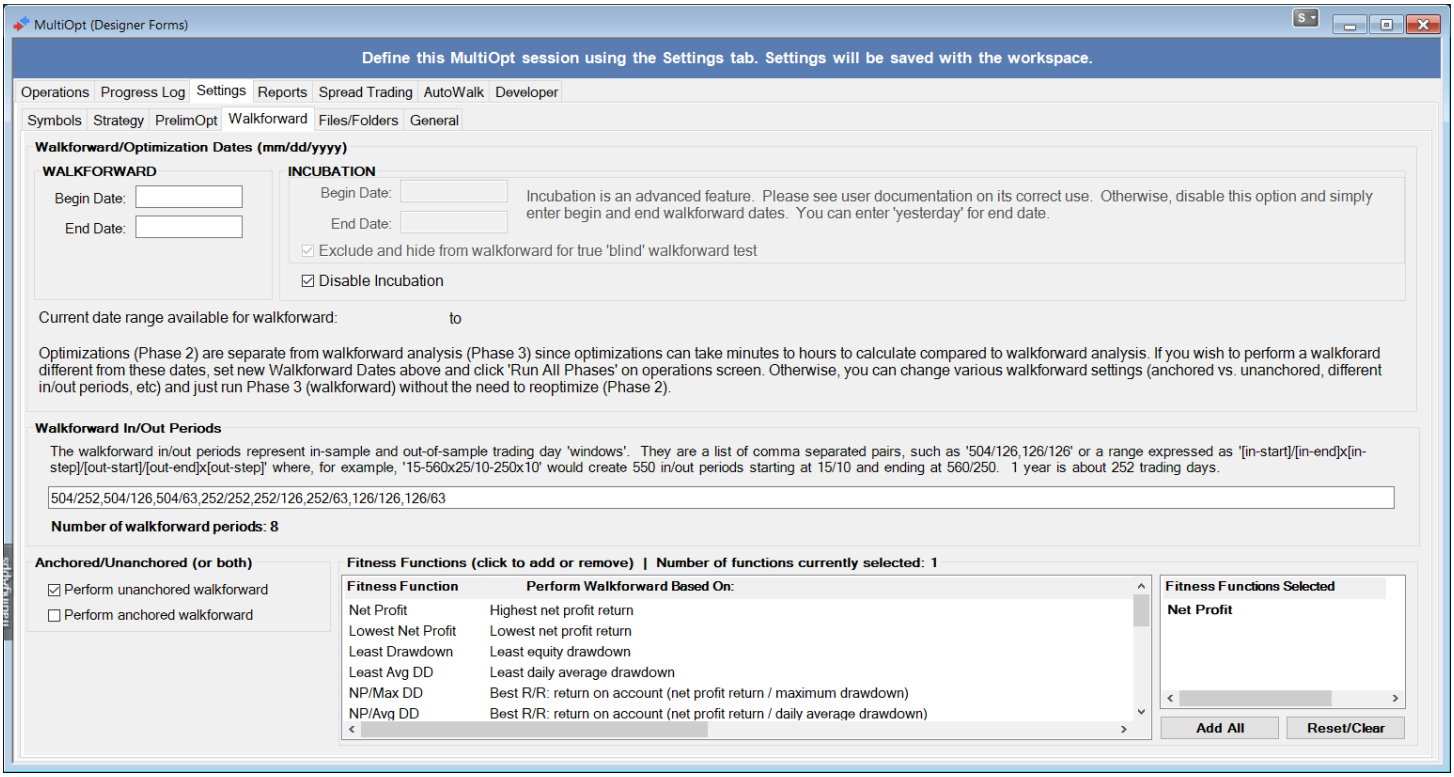
To avoid always running a preliminary optimization on the same two year time period strategy after strategy, you can have MultiOpt select a random time period for you.

Selection Criterion

Any strategy symbol/time frame that passes the **Selection Model** chosen will be available for Phase 2 testing. Current selection models are defined as follows:

> **Model 1**: Select symbol/time frames that have at least **Iteration Percent** greater than **Net Profit Threshold**. For example, if you wanted to include all strategy symbol/time frames that had at least 33% optimization iterations that were greater than $25k, then you would set **Iteration Percent** = 33 and **Net Profit Threshold** = 25000.
>
> **Model 2**: Select symbol/time frames that with **Iteration Percent** profitable (above zero) and highest iteration net profit greater than **Net Profit Threshold**.
>
> The "standard" club criteria for a 2-year preliminary analysis window is to select all symbol/time frames that have 70% or more optimization iterations that are profitable (i.e., above zero -- **Iteration Percent** = 70 and **Net Profit Threshold** = 0).

Walkforward



This screen configures that walkforward and incubation (if defined) periods.

Notice that there is a distinction between the optimized dates and walkforward dates.

Optimization Dates

Optimized dates will be displayed after running an optimization (Phase 2). We separate the optimization phase from walkforward phase since the optimization process takes much, much longer than walkforward testing. Therefore, if you wanted to run multiple walkforward tests, it would be a waste of time to optimize the strategy over the same time period again and again. This makes strategy develop much more rapid and efficient. The only time you would want to re-optimize the strategy is if you changes the walkforward time periods.

Walkforward Dates

There are two sets of walkforward dates – the primary walkforward time period and an incubation time period.

The primary walkforward dates are those that will usually be used to test a strategy. If you do not use an incubation period, this will be full walkforward time period up to current date.

Incubation Dates

Incubation is a term from Kevin Davey's workshop. He tests his strategies in real-time for a period of months (usually 6) in order to determine if the strategy performs as expected compared to the primary walkforward time period. I have incorporated this into MultiOpt's testing structure with one important difference – I am not using this in real-time, but rather *simulating* incubation by setting aside a chunk of data for final, walkforward testing. This makes the walkforward period and incubation period similar to the traditional concept of "in-sample" and "out-of-sample" testing.

If you are going to use incubation, then enable this option and enter the begin/end incubation dates. This is important to do so before optimizing so that the optimization in Phase 2 will optimize across the entire data set.

Fitness Functions

Fitness functions can also be considered *objective functions*. They offer a way to define various design objectives for each walkforward process. For example, if using Net Profit as a fitness functions, then the higher the net profit of the walkforward, the better this particular function achieves the objective.

During the walkforward analysis, each iteration from the optimization process (Phase 2) is evaluated for the defined in-periods (i.e., the "in" portion of the in/out walkforward period) of the walkforward. Remember that each optimized iteration (from Phase 2) represents a particular parameter configuration from the definitions on the Settings->Strategy page.

The "best" iteration for each in-period of the walkforward will be selected based on the fitness function being use. In this sense, what is "best" is defined by the fitness function. This is what creates the walkforward parameters found in the final stratregy code.

For example, the following walkforward dates represent the "best" choices based on the particular fitness function applied to the in-period of each walkforward:

```
// Walkforward dates and optimized paramenters
if date >= 1080425 and date < 1100409 then
begin
    ADXLength = 34;
    lookback = 10;
    stopval = 2000;
    profittarg = 3000;
end;
if date >= 1100409 and date < 1120321 then
begin
    ADXLength = 38;
    lookback = 26;
    stopval = 1000;
    profittarg = 6000;
end;
```

Caution Using Fitness Functions!

For a very long time, the only fitness function offered in MultiOpt was "Net Profit", which would select the highest performing net profit for each walkforward.

Due to numerous MultiOpt user requests, I added other fitness functions. Currently I have not evaluated them to determine if they perform any better in real-time than simply using Net Profit. If you do use a fitness function other than Net Profit, I encourage you to do your own due diligence and test and understand the fitness function you want to use thoroughly. *Do **not** simply run your strategy using multiple fitness functions and then choose the one that performed the best.* This would simply create a great looking equity curve that will probably not perform well in the future.

Equity Curve Metrics (Fitness Function List)

The following describe how each fitness functions is determining what is "best" for each iteration during the walkforward process.

Net Profit

Selection objective is highest overall net profit of each in-period walkforward window.

Lowest Net Profit

Selection objective is lowest overall net profit of each in-period walkforward window. This is simply the inverse of Net Profit fitness function and was added due to a user request who noticed that sometime choosing the *worst* net profit performer yielded better results.

Least Drawdown

Selection objective is least amount of equity drawdown in each in-period walkforward window.

Least Avg Drawdown

Selection objective is the least average drawdown in each in-period walkforward window. Drawdown is calculated on a daily basis and then averaged over the in-period walkforward window.

NP/Max Drawdown

Return (net profit) over maximum drawdown is a risk-adjusted return metric used to assess the risk:return ratio of the system. It is the way of asking the question Am I willing to accept an occasional drawdown of X% in order to generate an average return of Y%?" The higher this ratio, the better return to your risk exposure.

NP/Average Drawdown

This is identical to NP/Max Drawdown except that it measure the daily average drawdown volatility rather than the maximum drawdown of the entire time period. This metric is a great way to measure the "smoothness" of the equity curve. High daily average drawdowns will results in a very choppy equity curve. However, low daily drawdowns will result in a smoother ride, which results in a less ulcer inducing trading experience!

R^2 (+NP)

R^2 is the least squares regression analysis applied to the equity curve. It presents a measurement of the the slope of the equity curve and traditionally varies between 0-1, where 0 would look like a scatter chart and 1 would be a perfect upward (or downward) sloping straight line.

The least squares calculation itself does not distinguish between upward sloping lines or downward sloping curves. If R^2 had a value of 0.92, that could be a desirable upward slope OR a highly undesirable downward slope. Therefore, this particular fitness function will adjust the R^2 to be negative for downward sloping equity curves so that it can be used to selected only equity curves that are sloping upward.

Annualized Net Profit

Selection objective is the highest net profit annualized over a 12 month period. Recognize, however, that if you choose a small walkforward in-sample window, such as 3 months, that the annualization will be extrapolated as though it was over a 12 month period.

Annual NP/Average Drawdown

This fitness function is similar to NP/Average Drawdown, except it uses Annualized Net Profit in place of overall Net Profit.

TS Index M2M

This fitness function metric is based on TradeStation's Index. TradeStation Index maximizes the Net Profit and Winning Trades while minimizing Intraday Drawdown. It calculates this as:

Net Profit * NumWinTrades / AbsValue (Max. Intraday Drawdown)

MultiOpt does not collect actual trade data, but rather uses end-of-day mark-to-market profit/loss data. Therefore I use winning *days* rather than winning *trades* in the calculation. Therefore, the calculation becomes:

Net Profit * NumWinM2MDays / AbsValue (Max. Intraday Drawdown)

This has provided a result comparable to TradeStation's Index.

Highest Gross Profit

Selection objective is highest gross profit for each in-period walkforward window.

Least Gross Loss

Selection objective is least gross profit of each in-period walkforward window.

Profit Factor

Profit Factor is gross profit divided by gross loss. The higher the profit factor, the greater your profit over loss. Selection objective is highest profit factor of each in-period walkforward window.

Total Trades

Selection objective is highest number of trades of each in-period walkforward window.

Highest RunUp

Selection objective is profit run-up of each in-period walkforward window.

Highest NP x R^2

This fitness function is another way of modifying R^2 so that upward sloping curves are positive while negative sloping curves are negative. It, however, also adds the measurement of actual net profit. Higher net profit will yield larger values R^2 whereas lower net profit will reduce R^2, even if that R^2 was very high.

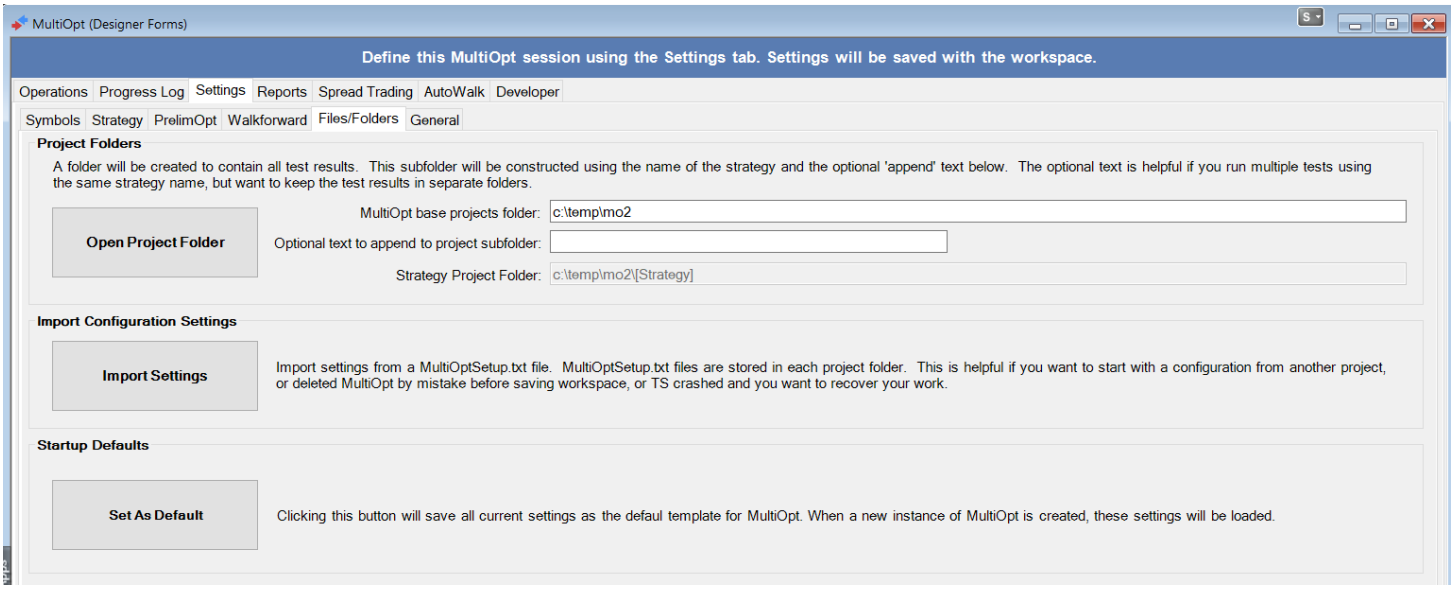
Highest NP x Profit Factor

Similar to Highest NP x R^2, this fitness function uses Profit Factor instead as the multiplier.

RINA

Not currently implemented.

Files/Folders



Project Folder

MultiOpt stores all files and settings in a project sub-folder under the **base folder name**. This sub-folder will be the strategy name + optional text. The optional text is appended to the sub-folder name in case you want to run multiple configurations for the same strategy, but have each run occupy its own folder.

Import Configuration

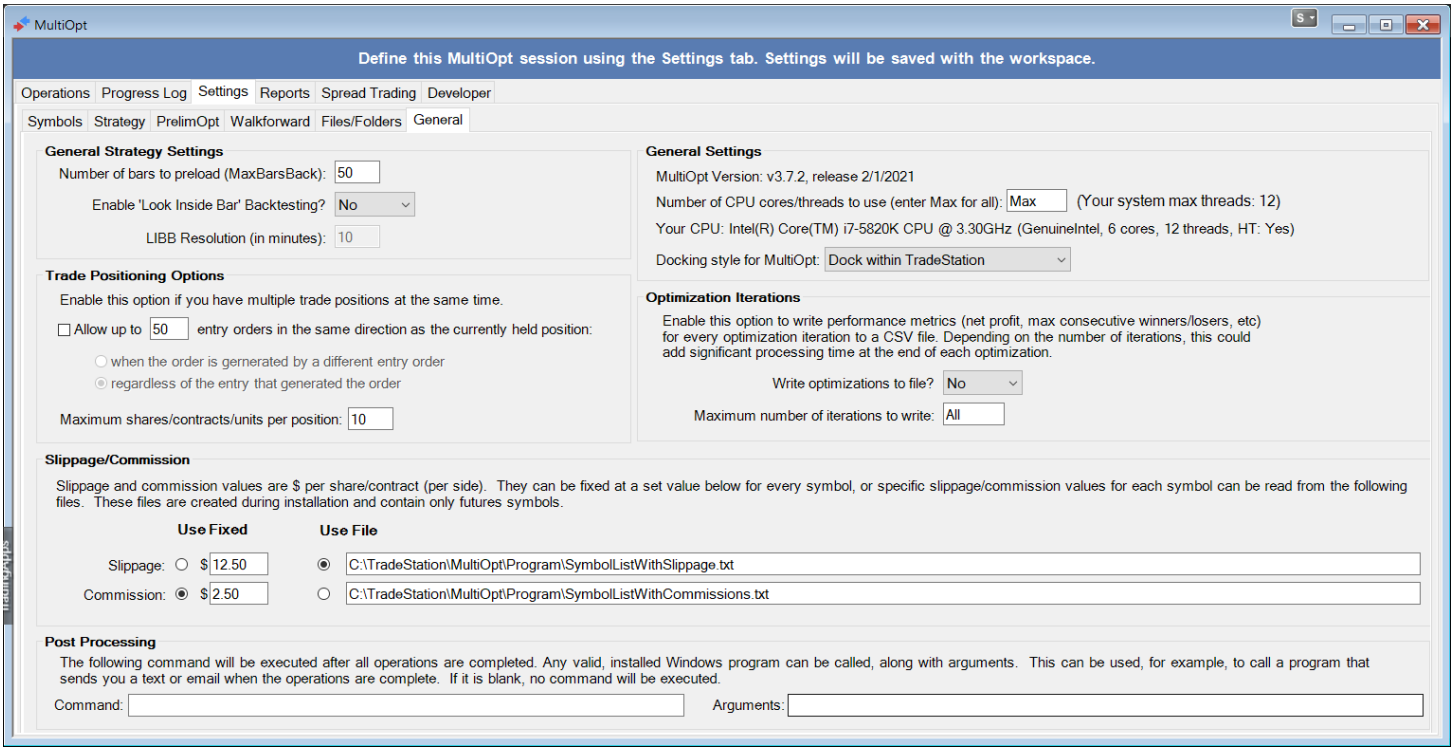
If, for some reason, you delete a workspace before saving your work, or TS crashes before you could save, or you simply want to retrieve settings from another project folder, you can import those settings from a special file that MultiOpt creates whenever it performs an optimization or walkforward process. This file, *MultiOptSetup.txt* is stored in the project sub-folder.

Please note, *all current settings will be overwritten when you import a configuration file*.

Set As Default

If you have a favorite default configuration that you would like to see loaded every time you start a new MultiOpt session, simply set up MultiOpt and then save this as your default template. New instances of MultiOpt will now use these values as their initial configuration.

General



Strategy Settings

Number of bars to preload (MaxBarsBack)

This is the number of bars that TradeStation will need to preload to seed your strategy so that all formulas it uses will be fully calculated (such as moving averages) before the start date of the session.

Enable Look Inside Bar Backtesting
LIBB Resolution (in minutes)

When enabled, TradeStation will load a smaller bar resolution "behind the scenes" in order to determine trade entry and exits. By default, this option is disabled simply because enabling LIBB will *substantially* increase the optimization times.

However, when you add the final strategy to a chart in TradeStation, it is a good idea to enable this option on the strategy property settings and compare the results with LIBB off and LIBB on. If there is a large discrepancy in the results, then your strategy is subject to changes in smaller resolution data and MultIOpt should be run again with LIBB enabled.

Trade Positioning (pyramiding)

If your strategy can place multiple trades at the same time, enable this option.

Slippage/Commission

Slippage and commission values are $ per share/contract (per side). They can be fixed at a set value for every symbol, or specific slippage/commission values for each symbol can be read from files. These files are created during installation and contain only futures symbols.

You can modify these files, however, be aware that they are overwritten when updating MultiOpt. So if you modify them, save your copies so that you can copy them back after the update.

General Settings

Number of CPU cores/threads

MultiOpt is multi-core safe! However, if you want to limit the number of cores used by MultiOpt, define them above, or simply leave the setting to "Max". This setting refers to the actual number of autonomous threads your system support (which is usually different than the number of CPU cores).

Docking Style

If you want to take advantage of more "screen real-estate" outside of TradeStation, you can undock MultiOpt so that you can maximize the window size.

Optimization Iterations

Enable this option to write performance metrics (net profit, max consecutive winners/losers, etc) for every optimization iteration to a CSV file. Depending on the number of iterations, this could add significant processing time at the end of each optimization.

The files created will be created in the project folder and named *AllOptIterations [strategy name] [symbol/timeframe] [BeginDate to EndDate].csv*

Use "Open Project" under Settings->Files/Folders to open a window to the project folder.

Post Processing

This allows you to define a program to run after the MultiOpt session completes. For example, you can have MultiOpt execute a program, such as SwithMail (https://sourceforge.net/projects/swithmail), that sends you an email when the session completes.

For example, if you installed SwithMail in C:\SwithMail, you could define:

- Command: C:\SwithMail\SwithMail.exe
- Arguments: /s /from "john@doe.net" /to "john@doe.net" /name "John Doe" /pass "<your password here>" /server "mail.gandi.net" /p "587" /SSL /sub "MultiOpt Project Completed" /b "Your MultiOpt project completed at %now%"

Of course, you would just replace my information with your own, unless of course you really want me to know when your MultiOpt project completes! ☺

You could also use it to call an audio program, such as Windows Media Player, that plays a bell sound audio file. The command would be the audio program and the argument would be the path/filename of the bell audio file. I found many media sound files under C:\Windows\Media. Take a look to see what you have on your system. I found this one pretty cool:

- Command: C:\Program Files\Windows Media Player\wmplayer.exe
- Arguments: C:\Windows\Media\Alarm10.wav

Another option as of version 3.7.5 is to use the built-in command "popup". This will create a message box on your screen when a MultiOpt session completes. Here's how you can configure it:

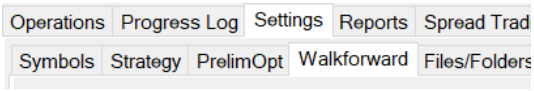
- Command: popup
- Arguments: MultiOpt session has finished! (or whatever message you want displayed in popup box)

MultiOpt Data Analysis Reports

MultiOpt will create the following analysis reports files and store them in the project subfolder. You can click on the header of any of the columns to sort the entries. Or, you can click the "Open" button to load the CSV report file into your default spreadsheet application (such as Excel).

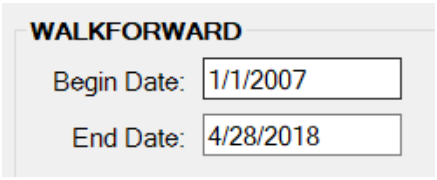
In-Sample and Out-Of-Sample Terminology

The reports use the traditional terms "in-sample" and "out-of-sample" to refer to two sets of data that you defined on the Walkforward Settings page:



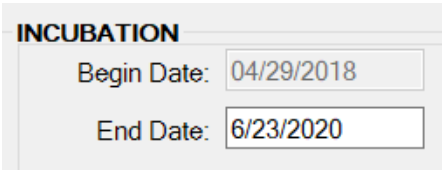
In-Sample ("Walkforward" dates)

This is the data that contains the dates you defined as "Walkforward" dates:



Out-Of-Sample ("Incubation" dates)

This is the data that contains the dates you defined as "Incubation" dates:



Report Filters

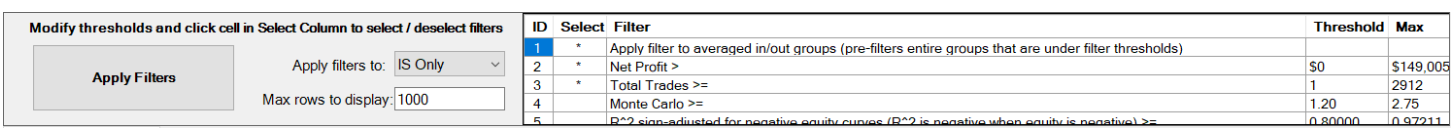
The walkfoward metric reports are filtered according to a criteria that you define. MultiOpt can produce massive amounts of data – far beyond what TradeStation was ever designed to handle. I found that when TradeStation tries to display more than 10,000 rows of data in their spreadsheet GUI objects, that it slows down immensely. One time I waited 20 minutes before it finally displayed my data!

So I redesigned the reporting system so that data we probably don't care to see (such as equity curves that lose money) can be filtered out and not displayed in the report. The original data still exists and can be loaded into a spreadsheet program, such as Excel, if you want to view the entire data set.

I also use the filtering system to drill down into the data in order to find those markets that pass my personal minimum criteria, such as Monte Carlo > 1.0.

To turn a filter on or off, click in the "Select" column. Set the filter's threshold in the "Threshold" column. The maximum values in the entire data set are displayed in the "Max" column. If your report is not displaying any entries, this "Max" column will help you understand why since it shows you the maximum values that were generated in your MultiOpt project.

The following filtering options are available:



Apply Filters to

This option determines what data set the metric filters will be applied to – In-Sample or Out-Of-Sample.

Max rows to display

This option will limit the number of rows displayed in the spreadsheet. TradeStation is not efficient when displaying large amounts of data, so be careful how high you set this number. However, be aware that if your filtered set has, for example, 5000 rows and you are only displaying 1000 rows, then 4000 rows of that data will be hidden unless you (1) change your filter criteria or (2) increase the number of rows displayed.

Filter "Apply filter to averaged in/out groups (pre-filters entire groups that are under filter thresholds)"

Since I am interested in the average performance of a strategy across many in/out periods, I have two reports – one that displays the average of all in/out periods for any given market/time frame/fitness function and one that displays all the individual entries that comprise that average.

This option will apply the metric filter to the average of the group. If the average is below the minimum threshold criteria of the filter, all entries in that group will be filtered out, *even if some of the individual entries would have passed the criteria*. In other words, if the average performance was below the filter criteria, then none of those entries will be displayed in the report.

All Other Filters

All other filters define the minimum thresholds necessary to be included in report. For example, if you define Net Profit filter as "50,000" then only entries that make $50,000 or more will be included in the report.

Preliminary Optimization Report

File name in MultiOpt project folder: "Optimization Results (preliminary candidates).csv"

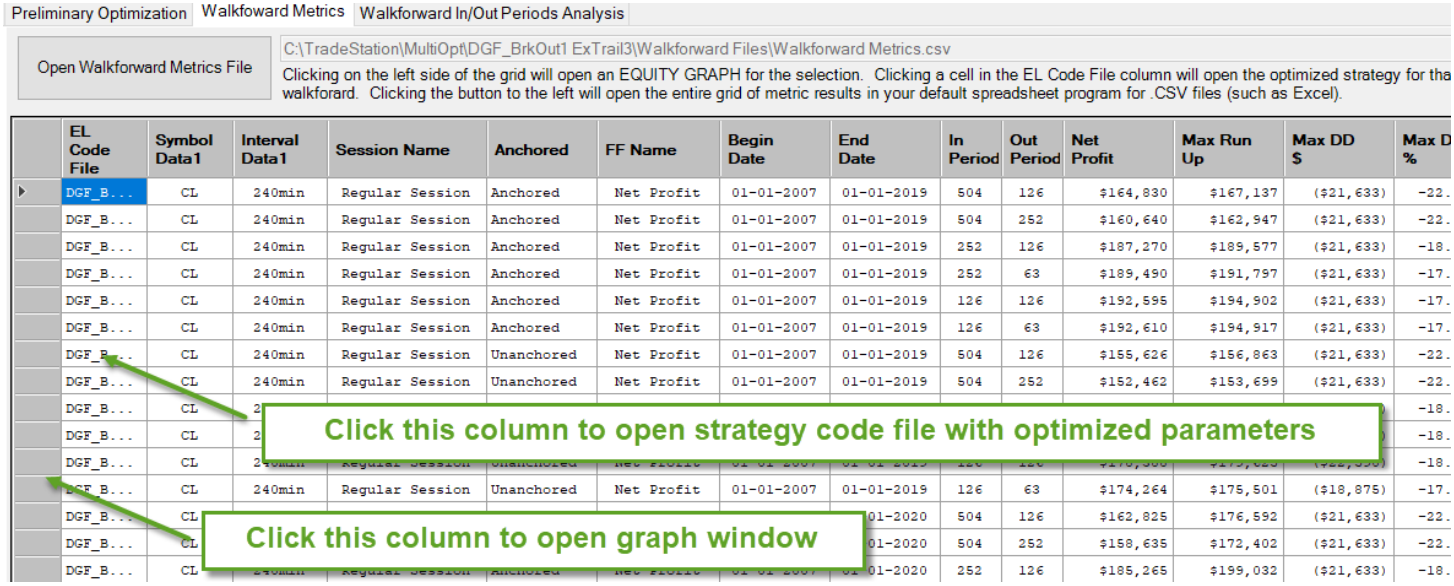
This file contains the results from the preliminary optimization dates. The first column in the report is used to mark entries with an asterisk that should be analyzed in Phase 2. Each line in this file contains the final results of an optimization for each symbol/time frame, including such information as the number of iterations that satisfied selection criteria, highest profit iteration, lowest loss iteration, etc).

An example of this report will look as follows:

	Passing	Data1 Symbol	Data1 Chart Interval	Session	Begin Date	End Date	Total Years	Total Iters	Total Iterations Satisfying Selection Model	Iterations Satisfying Selection Model (%)	Total Iterations Profitable (> $0)	Iterations Profitable (%)	Iteration Highest Net Profit ($)	Iteration Lowest Net Profit ($)
▶	*	@ES	Daily	Regular Session	6/1/2016	6/1/2018	2	792	792	100%	792	100%	$21,555	$768
		@GC	Daily	Regular Session	6/1/2016	6/1/2018	2	792	0	0%	0	0%	$0	$0
		@CL	Daily	Regular Session	6/1/2016	6/1/2018	2	792	0	0%	0	0%	$0	$0
		@PL	Daily	Regular Session	6/1/2016	6/1/2018	2	792	0	0%	0	0%	$0	$0
	*	@ES	360min	Regular Session	6/1/2016	6/1/2018	2	792	773	98%	773	98%	$24,860	($8,040)
	*	@GC	360min	Regular Session	6/1/2016	6/1/2018	2	792	618	78%	618	78%	$35,243	($24,654)
	*	@CL	360min	Regular Session	6/1/2016	6/1/2018	2	792	756	95%	756	95%	$29,546	($5,035)
		@PL	360min	Regular Session	6/1/2016	6/1/2018	2	792	90	11%	90	11%	$6,862	($21,229)
	*	@ES	240min	Regular Session	6/1/2016	6/1/2018	2	792	705	89%	705	89%	$21,740	($16,465)
	*	@GC	240min	Regular Session	6/1/2016	6/1/2018	2	792	486	61%	486	61%	$30,503	($42,532)
	*	@CL	240min	Regular Session	6/1/2016	6/1/2018	2	792	777	98%	777	98%	$29,666	($5,314)
		@PL	240min	Regular Session	6/1/2016	6/1/2018	2	792	261	33%	261	33%	$12,607	($22,799)

Walkforward Metrics Report

This report contains the performance metrics for every market, time frame, and walkforward in/out period defined in the project. From this report, you can display a graph of equity results of the walkforward, or display the actual strategy code with optimized parameters that would be added to a chart in TradeStation and traded in real-time.



EL Code File	Symbol Data1	Interval Data1	Session Name	Anchored	FF Name	Begin Date	End Date	In Period	Out Period	Net Profit	Max Run Up	Max DD $	Max D %
DGF_B...	CL	240min	Regular Session	Anchored	Net Profit	01-01-2007	01-01-2019	504	126	$164,830	$167,137	($21,633)	-22.
DGF_B...	CL	240min	Regular Session	Anchored	Net Profit	01-01-2007	01-01-2019	504	252	$160,640	$162,947	($21,633)	-22.
DGF_B...	CL	240min	Regular Session	Anchored	Net Profit	01-01-2007	01-01-2019	252	126	$187,270	$189,577	($21,633)	-18.
DGF_B...	CL	240min	Regular Session	Anchored	Net Profit	01-01-2007	01-01-2019	252	63	$189,490	$191,797	($21,633)	-17.
DGF_B...	CL	240min	Regular Session	Anchored	Net Profit	01-01-2007	01-01-2019	126	126	$192,595	$194,902	($21,633)	-17.
DGF_B...	CL	240min	Regular Session	Anchored	Net Profit	01-01-2007	01-01-2019	126	63	$192,610	$194,917	($21,633)	-17.
DGF_B...	CL	240min	Regular Session	Unanchored	Net Profit	01-01-2007	01-01-2019	504	126	$155,626	$156,863	($21,633)	-22.
DGF_B...	CL	240min	Regular Session	Unanchored	Net Profit	01-01-2007	01-01-2019	504	252	$152,462	$153,699	($21,633)	-22.
DGF_B...	CL	2											-18.
DGF_B...	CL	2											-18.
DGF_B...	CL	2											-18.
DGF_B...	CL	240min	Regular Session	Unanchored	Net Profit	01-01-2007	01-01-2019	126	63	$174,264	$175,501	($18,875)	-17.
DGF_B...	CL						01-01-2020	504	126	$162,825	$176,592	($21,633)	-22.
DGF_B...	CL						01-01-2020	504	252	$158,635	$172,402	($21,633)	-22.
DGF_B...	CL						01-01-2020	252	126	$185,265	$199,032	($21,633)	-18.

Metrics

- **Net Profit** - total profit/loss made during the define time period
- **R^2 "r-squared"** – this is the least squares "best fit" regression line of your equity curve. The value of 1 is a perfect fit and a value of zero is no fit – the data is equally dispersed around the line. The closer the value is to 1, the better.
- **WF efficiency** – this is how "efficiently" the OOS walkforward periods compared to the IS walkforward periods. A value of 100% means that OOS periods performed exactly like the IS periods. Specifically, WF efficiency is the annualized rates of return for the out-of-sample results divided by the in-sample results.
- **Max DD** – this is the maximum dollar drawdown for the time period.
- **Avg DD** – this is an average of the daily drawdown fluctuations. The result is a "smoothness" measurement for the equity curve. The smaller the Average Drawdown, the less volatility in the daily equity ups-and-downs. In other words, the smaller the Average Drawdown, the smoother the equity curve. The higher the Average DD, the more "jagged" or "seismic" the equity curve. Even if the equity curve is rising upward at a nice slope (R^2), a smaller Average DD will provide a less anxious, ulcer-producing ride than a large Average DD!
- **Return/Max DD** – this is the risk:return ratio based on maximum drawdown. It is the total net profit divided by the maximum drawdown and is a common metric to measure risk, sometimes also referred to as "Return On Account" (ROA). Anything above a 1:3 ratio is considered good.
- **Return/Average DD** – this is the risk/return ratio based on average drawdown. It is the total net profit divided by the average drawdown and assess the "smoothness" of the equity curve. Higher ratios have less drawdown fluctuations. Lower ratios are more "seismic" and jagged.
- **Monte Carlo** analysis is a means to stress-test the trading results by randomly "mixing up" the daily equity fluctuations into different outcomes. Any score of 1.0 or greater should be investigated further. Kevin Davey provides a spreadsheet for Monte Carlo analysis as part of his Strategy Factory workshop. MultiOpt is based on the algorithm that Kevin used in this spreadsheet. Both MultiOpt and Kevin's spreadsheet compute 2500 randomized distributions. However, there are these differences:
    1. Kevin's spreadsheet uses trade results, MultiOpt uses daily mark-to-market equity balances at the end of each day.
    2. Kevin's spreadsheet does not have a fixed starting equity. Margin requirement tends to be used as the starting equity. MultiOpt uses a fixed starting equity of $25,000 and equity quit-trading point of $5,000.

3. Kevin's spreadsheet computes an MC score until a 10% risk of ruin is reached. He requires this score to be 2.0 or greater for a strategy to be considered tradeable. MultiOpt does not repeat for different risk of ruin scores, but rather computes one MC score for each 2500 iterations.

While a 2.0 in Kevin's spreadsheet is not guaranteed with MultiOpt scores over 1.0, Kevin has found that there is a 90% chance that MultiOpt's MC score of 1.1 or greater will be over 2.0 in his spreadsheet.

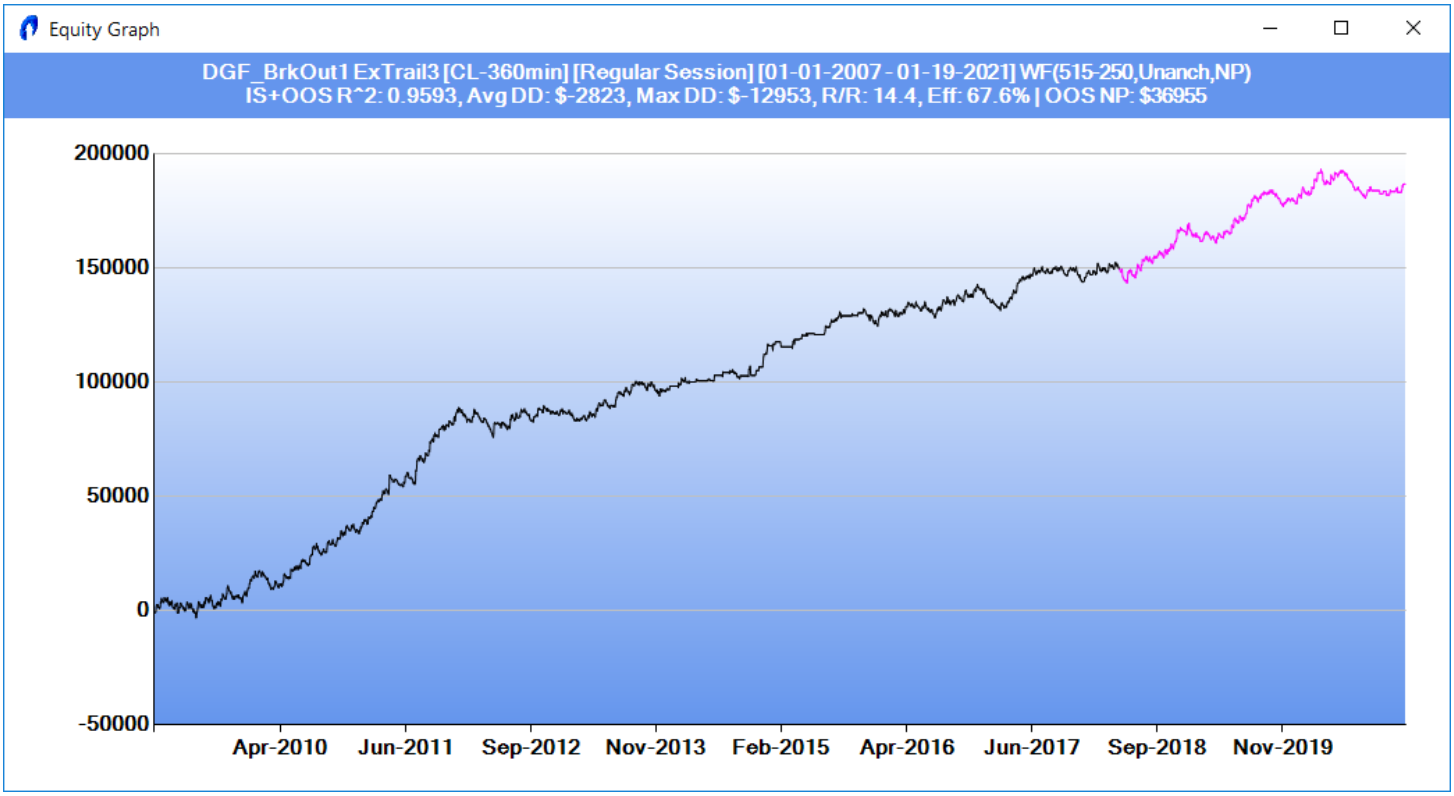
- **Annualized Net Profit and Annualized Return/Average DD** – These are annualized forms of the corresponding metrics. They make it possible to compare metrics across a variety of different symbols and equity curves.

Return/Avg DD (smoothness) metric combined with R^2 (slope incline) create nice combination to assess the trading experience for any given equity curve.

Graph of Equity Results

Clicking on any row will open a graph of the equity curve for that particular walkforward.

If you have an incubation period defined, the incubation period will be displayed in pink.



Strategy Code For Real-Time Trading

When you click on the "EL Code File" column, it will open the actual strategy code for real-time trading. Copy this to a strategy in TradeStation Development Environment/Editor and attach it to the chart symbol and time frame indicated in the header of the strategy file.

The head contains all the information you will need to configure the chart in TradeStation so that it matches the same configuration in MultiOpt.

The following is a header example of the strategy that produced the above equity graph:

```
//
// MultiOpt Strategy with Optimized Walkforward Parameters
//
// This strategy is the result of the walkforward process and contains the walkforward optimized parameters for real-time
// trading.  Copy this strategy code to a new strategy (do not overwrite your MultiOpt version of this strategy). Give
// it a unique name, such as "DGF_BrkOut1 ExTrail3 (CL-360min)"
//
// Then add that strategy to a TradeStation chart. Configure the chart using the settings below.
```

```
//
// MultiOpt Strategy Name  : DGF_BrkOut1 ExTrail3
// Optimized Strategy File : C:\TradeStation\MultiOpt\DGF_BrkOut1 ExTrail3-DELETEME\Walkforward Files\DGF_BrkOut1 ExTrail3
[CL-360min] [Regular Session] [01-01-2007 - 01-19-2021] WF(515-250,Unanch,NP) ELCode.txt
//
// TRADESTATION CHART SETUP INFORMATION
//
// Be sure to configure the chart in TradeStation using the SAME settings that were used in MultiOpt, otherwise
// your results will not match those found in MultiOpt.  Use the settings below to create your TradeStation chart.
// ---------------------------------------------------------------------------------------------------------------
//
// Symbol Settings
//
// Symbol/Interval Data1               : CL 360min
// Symbol/Interval Data2               :
// Symbol/Interval Data3               :
// Session Name                        : Regular Session
// Begin Date                          : 01-01-2007
// End Date                            : 01-19-2021
// Time Zone                           : Exchange Time
// Bar Building Method                 : Session Hours
// For Volume, Use                     : Trade Vol
//
// Strategy Settings
//
// Slippage                            : 15.00 ($ per share/contract)
// Commission                          : 2.50 ($ per share/contract)
// Limit Order Fill Assumption         : Fill entire order when trade price exeeds limit price
// Maximum number of bars (MaxBarsBack): 110
// Look-Inside-Bar Backtesting (LIBB)  : No
// Multiple position/pyramiding enabled: No
//
// OPTIMIZATION/WALKFORWARD INFORMATION
//
// The following are the optimzation and walkforward settings used in MultiOpt to create this strategy.  They can
// be used to create a MultiOpt project for reoptimization.
// ---------------------------------------------------------------------------------------------------------------
//
// Optimization Settings
//
// Total number of iterations          : 792
// Optimization Variables (name, start, end, step interval):
//    BarsBack,10,110,10
//    ProfitThresholdStart,500,1500,500
//    TrailingFloorPercentStart,30,80,10
//    StopLossDollars,500,2000,500
//
// Walkforward Settings
//
// Anchored/Unanchored                 : Unanchored
// Fitness Function                    : Net Profit (Highest net profit return)
// In/Out Periods                      : 515/250
//
```

Walkforward In/Out Periods Analysis

These walkforward reports are can be used to identify potential strategies to trade in real-time.

In order to take advantage of this analysis, you will need to define both a walkforward (in-sample) period and incubation (out-of-sample) period.

Please see the section "Putting It All Together" for more information on this process.

IS/OOS Walkforward Averages

This report presents the average performance of ALL in/out periods defined in the Walkforward Settings screen.

Group ID	Symbol Data1	Interval Data1	Session Name	Anchored	Fitness Function	IS Begin Date	IS End Date	OOS Begin Date	OOS End Date	Total In/Out Periods	IS Average Net Profit	IS Average R^2	IS Average Return/Ma DD	IS Average Return/Av DD
1	CL	120min	Regular Session	Unanchored	Net Profit	01-01-2007	04-28-2018	04-28-2018	06-20-2020	8	$103,096	0.718450	4.47	15.59
3	CL	240min	Regular Session	Unanchored	Net Profit	01-01-2007	04-28-2018	04-28-2018	06-20-2020	8	$113,311	0.861980	5.16	20.07
5	CL	30min	Regular Session	Unanchored	Net Profit	01-01-2007	04-28-2018	04-28-2018	06-20-2020	8	$54,722	0.619460	1.70	5.47
7	CL	360min	Regular Session	Unanchored	Net Profit	01-01-2007	04-28-2018	04-28-2018	06-20-2020	8	$117,127	0.915260	6.49	30.82
9	CL	60min	Regular Session	Unanchored	Net Profit	01-01-2007	04-28-2018	04-28-2018	06-20-2020	8	$77,728	0.758260	2.87	9.11
11	GC	120min	Regular Session	Unanchored	Net Profit	01-01-2007	04-28-2018	04-28-2018	06-20-2020	8	$46,687	0.543220	1.73	4.62
13	GC	240min	Regular Session	Unanchored	Net Profit	01-01-2007	04-28-2018	04-28-2018	06-20-2020	8	$76,353	0.818990	3.21	13.56
15	GC	360min	Regular Session	Unanchored	Net Profit	01-01-2007	04-28-2018	04-28-2018	06-20-2020	8	$66,900	0.886130	3.57	13.68

In the above analysis, 8 in/out periods were defined for this project. Therefore, each row represents a group of 8 in/out periods (averaged together).

IS/OOS Walkforward Averages Detail

This report breaks out the details of each walkforward group in the IS/OOS Walkforward Averages report so that you can see the individual walkforwards that are included in each averaged group. You can click on the "EL Code File" column to display the actual EasyLangage Code that can be used in real-time trading.

Group ID	Symbol Data1	Interval Data1	Session Name	Anchored	Fitness Function	EL Code File	In/Out Period	IS Begin Date	IS End Date	IS Net Profit	IS R^2	IS Return/Ma DD	IS Return/Av DD	IS WF Efficiency
1	CL	120min	Regular Session	Unanchored	Net Profit	My S...	252/252	01-01-2007	04-28-2018	$127,358	0.645450	4.87	13.84	40.93%
1	CL	120min	Regular Session	Unanchored	Net Profit	My S...	504/252	01-01-2007	04-28-2018	$131,690	0.924740	7.95	32.16	55.50%
1	CL	120min	Regular Session	Unanchored	Net Profit	My S...	252/126	01-01-2007	04-28-2018	$137,310	0.787070	5.45	19.30	46.29%
1	CL	120min	Regular Session	Unanchored	Net Profit	My S...	504/126	01-01-2007	04-28-2018	$112,485	0.829030	6.67	25.26	45.45%
1	CL	120min	Regular Session	Unanchored	Net Profit	My S...	126/126	01-01-2007	04-28-2018	$65,555	0.819760	1.85	6.72	16.83%
1	CL	120min	Regular Session	Unanchored	Net Profit	My S...	126/63	01-01-2007	04-28-2018	$49,780	0.379240	1.10	3.63	11.40%
1	CL	120min	Regular Session	Unanchored	Net Profit	My S...	252/63	01-01-2007	04-28-2018	$100,565	0.585060	3.81	10.59	32.13%
1	CL	120min	Regular Session	Unanchored	Net Profit	My S...	504/63	01-01-2007	04-28-2018	$100,025	0.777240	4.03	13.25	43.31%
3	CL	240min	Regular Session	Unanchored	Net Profit	My S...	504/252	01-01-2007	04-28-2018	$110,670	0.925210	5.39	25.71	47.13%
3	CL	240min	Regular Session	Unanchored	Net Profit	My S...	252/252	01-01-2007	04-28-2018	$123,905	0.846590	5.14	20.05	38.02%
3	CL	240min	Regular Session	Unanchored	Net Profit	My S...	252/126	01-01-2007	04-28-2018	$108,930	0.716450	4.04	13.63	35.30%
3	CL	240min	Regular Session	Unanchored	Net Profit	My S...	126/126	01-01-2007	04-28-2018	$142,225	0.951610	5.31	23.75	36.05%
3	CL	240min	Regular Session	Unanchored	Net Profit	My S...	504/126	01-01-2007	04-28-2018	$103,063	0.922340	5.02	26.31	42.71%
3	CL	240min	Regular Session	Unanchored	Net Profit	My S...	126/63	01-01-2007	04-28-2018	$127,660	0.862220	5.56	17.20	30.67%

Putting It All Together

Remember that MultiOpt is both a strategy development AND a data analysis tool. The data reports generated by MultiOpt can be used for both objectives.

The number of ways you can use these data reports for deeper analysis of your strategies are more numerous that can be covered in any manual. You are encouraged to analyze the data produced by MultiOpt in ways that are useful for you.

This section of the manual will focus on using the reports for strategy selection as part of the development process, not necessarily data analysis.

Kevin Davey, in his Strategy Factory Workshop, suggests that you use only one in/out period to avoid curve fitting. There is risk in analyzing multiple in/out periods, which is the temptation to choose the best in/out performer. That would be just another form of curve fitting the data to your expectations. He also suggests that if you do look at other in/out combinations, that you choose one that is close to the average of all the in/out walkforward periods. In other words, don't take the best or worst performer, but one in the middle. This will also reduce your chance of curve fitting.

Personally, I like to see fairly good performance across a spectrum of in/out periods. This takes the pressure off of selecting the "right" one and gives me more confidence with the strategy.

When I took Kevin's course, his suggestions were:

504/126 – if that is good, he stops. If not, he goes to
252/63 – if that is good, he stops. If not, he may try
504/252, 252, 126 and 1 or 2 others.

These periods are pre-populated in new MultiOpt projects when you add MultiOpt to a workspace.

If you are just beginning with algorithmic development and trading, it is probably best use Kevin's standard in/out methodology and disable the INCUBATION checkbox on the Walkforward screen. Then, run your algorithm in real-time for 6 months.

Otherwise, if you want to analyze various in/out walkfoward periods and use the simulated incubation feature of MultiOpt (rather than wait 6 months in real-time), please see following section "Using Simulated Incubation and Walkforward Reports".

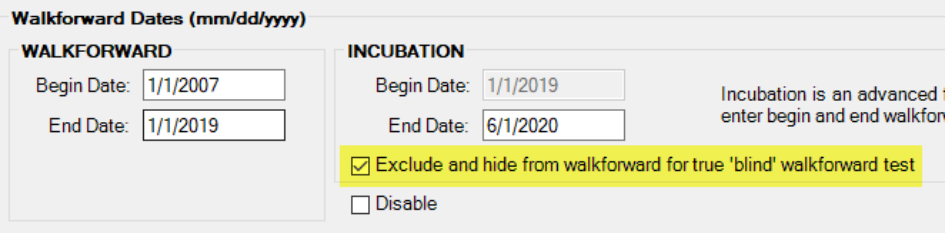
Using Simulated Incubation and Walkforward Reports

My basic premise is that I want to see fairly good performance across many of the walkforward in/out periods. I select strategies based on that premise as well as other performance metrics.

I strongly urge you to download the video tutorials to fully understand this final section. See the section *Video Tutorial: The Basics From Start To Finish* in this manual for the download links.

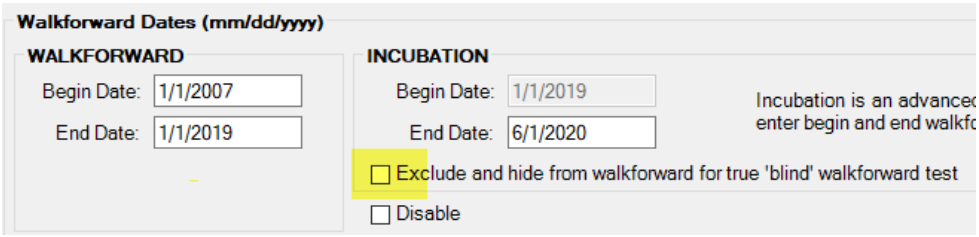
My process is as follows:

1. Define both walkforward and incubation time range, but check the Exclude option *so that the out-of-sample/incubation results are not part of the analysis reports or graphs*.



2. Perform analysis (Phases 1-3 on the Operations screen)
3. Study the Walkforward In/Out Periods Analysis reports and identify the walkforward(s) that you would trade in real-time.

4. *Uncheck* the Exclude option so that the out-of-sample/incubation time period will be included in the walkforward.



5. Perform the walkforward (Phase 3) ONLY. Do not do Phase 1 or 2 again.
6. Look at the incubation performance of the specific walkforwards you chose for real-time trading. How did they do? Did they perform as expected? If not, then ditch the strategy – it did not work. If so, then you may have a viable strategy to trade!

Be Careful, Be Honest!

Please note that to do this process *honestly*, you can only run the incubation step ONCE. If you decide to go back and make changes to the strategy after seeing the incubation/out-of-sample results, then you are simply optimizing for the incubation time period and your out-of-sample has now become in-sample. If I do this, then I track the strategy in real-time for a live incubation testing period.

Setup

I usually set aside 1-2 years of data for incubation/out-of-sample. But this can also be 6 months for Kevin's incubation period or even something like a 80/20 percent split of the entire time period. Simply use however much time makes sense for your strategy and market time interval.

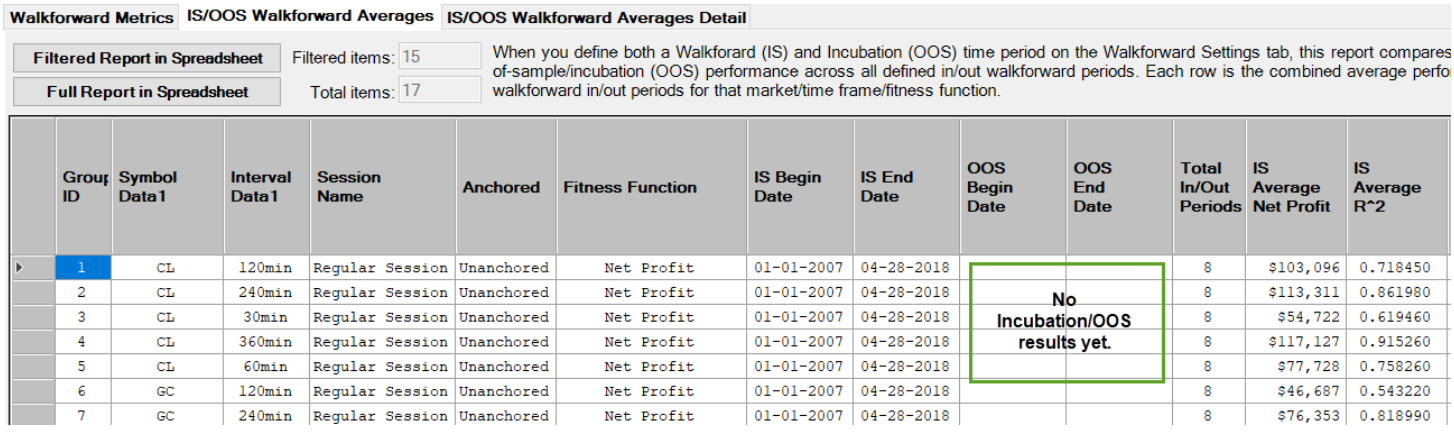
I define at least 8 or more in/out walkforward periods that represent a cross section across the entire in/out period landscape. After I make my selection(s) of the markets and time frames that look tradable, I'll run the incubation/out-of-sample period to see how they performed.

Looking at Pre-Incubation Results

Once you run Phase 2 and Phase 3, the *IS/OOS Walkforward Averages* report can be used to choose the market and time frame walkforward(s) that you consider worthwhile to trade in real-time.

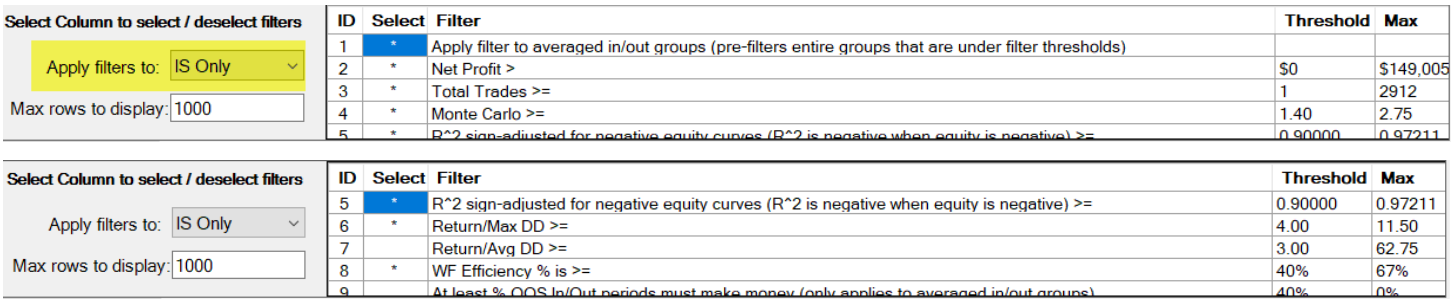
To help in this selection process, you can filter the data results using a variety of filters. Defining minimum thresholds will quickly filter the data so that it displays a walkforward average group that I want to look at more closely in the *IS/OOS Walkforward Average Details* report.

The default filters will remove any entries that have a negative net profit or no trades. This produced 15 filtered entries in the following example. Two entries were filtered out of the list because they were below filter thresholds:



Group ID	Symbol Data1	Interval Data1	Session Name	Anchored	Fitness Function	IS Begin Date	IS End Date	OOS Begin Date	OOS End Date	Total In/Out Periods	IS Average Net Profit	IS Average R^2
1	CL	120min	Regular Session	Unanchored	Net Profit	01-01-2007	04-28-2018			8	$103,096	0.718450
2	CL	240min	Regular Session	Unanchored	Net Profit	01-01-2007	04-28-2018			8	$113,311	0.861980
3	CL	30min	Regular Session	Unanchored	Net Profit	01-01-2007	04-28-2018			8	$54,722	0.619460
4	CL	360min	Regular Session	Unanchored	Net Profit	01-01-2007	04-28-2018			8	$117,127	0.915260
5	CL	60min	Regular Session	Unanchored	Net Profit	01-01-2007	04-28-2018			8	$77,728	0.758260
6	GC	120min	Regular Session	Unanchored	Net Profit	01-01-2007	04-28-2018			8	$46,687	0.543220
7	GC	240min	Regular Session	Unanchored	Net Profit	01-01-2007	04-28-2018			8	$76,353	0.818990

You can choose other filters to further narrow down your selections, such as Monte Carlo or Walkforward Efficiency:



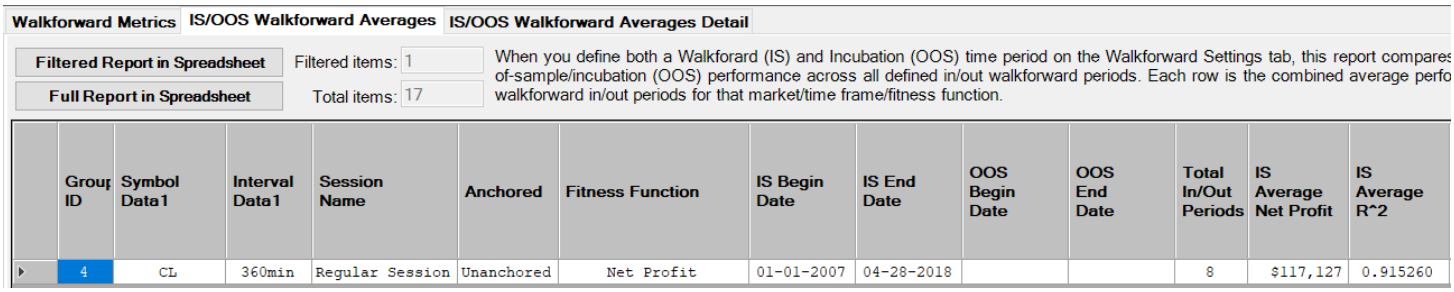
Select Column to select / deselect filters

Apply filters to: IS Only

Max rows to display: 1000

ID	Select	Filter	Threshold	Max
1	*	Apply filter to averaged in/out groups (pre-filters entire groups that are under filter thresholds)		
2	*	Net Profit >	$0	$149,005
3	*	Total Trades >=	1	2912
4	*	Monte Carlo >=	1.40	2.75
5	*	R^2 sign-adjusted for negative equity curves (R^2 is negative when equity is negative) >=	0.90000	0.97211
6	*	Return/Max DD >=	4.00	11.50
7		Return/Avg DD >=	3.00	62.75
8	*	WF Efficiency % is >=	40%	67%
9		At least % OOS In/Out periods must make money (only applies to averaged in/out groups)	40%	0%

This produced the following report:



Walkforward Metrics | IS/OOS Walkforward Averages | IS/OOS Walkforward Averages Detail

Filtered Report in Spreadsheet | Filtered items: 1

Full Report in Spreadsheet | Total items: 17

When you define both a Walkforard (IS) and Incubation (OOS) time period on the Walkforward Settings tab, this report compares of-sample/incubation (OOS) performance across all defined in/out walkforward periods. Each row is the combined average perfo walkforward in/out periods for that market/time frame/fitness function.

Group ID	Symbol Data1	Interval Data1	Session Name	Anchored	Fitness Function	IS Begin Date	IS End Date	OOS Begin Date	OOS End Date	Total In/Out Periods	IS Average Net Profit	IS Average R^2
4	CL	360min	Regular Session	Unanchored	Net Profit	01-01-2007	04-28-2018			8	$117,127	0.915260

Only one averaged group satisfied the filter criteria.

At this point we are only looking at pre-incubation “in-sample” results. I configured MultiOpt earlier so that incubation results will not be included in the reports. This gives me the ability to do an honest “blind” selection using only these pre-incubation results.

If there are no entries in the filtered list, then I may lower my expectations and set new thresholds or, more likely, simply ditch the strategy and move on.

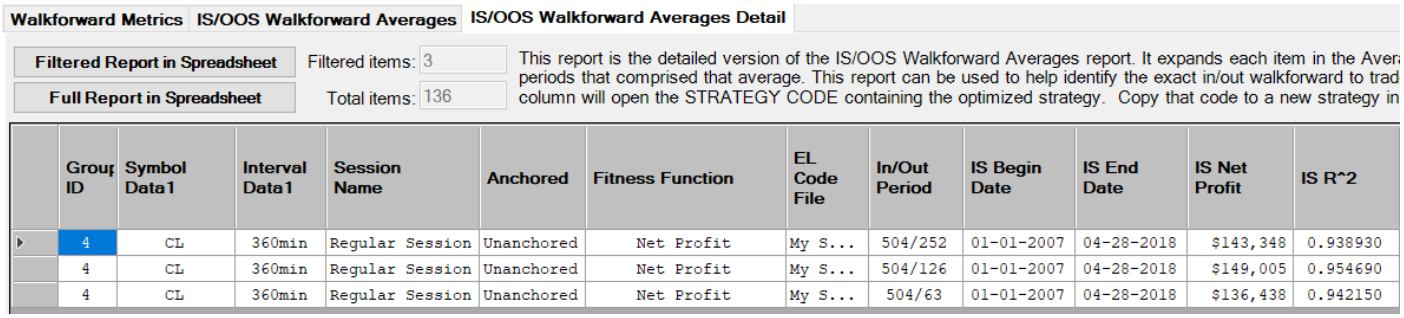
Remember that in addition to being an automation tool, MultiOpt is also a data analysis and research tool. Therefore many filters are included as part of the data analysis functions of MultiOpt. Unless you have done in-depth analysis of the criteria you use, you run the risk of just filtering data to present the best historical equity curves that conform to your biases and expectations. This does not mean that the filter criteria that you use will be predictive of the same future results. Unfortunately, there is no black-and-white criteria here, so I encourage you to do your own research and develop your own criteria.

If you are new to algorithmic development, then it is probably best to keep things simple and simply filter for Monte Carlo results > 1.3.

Selecting the Walkforward

If at this point I have some filtered “average group” entries, I’ll look at the *IS/OOS Walkforward Averages Details* report and look for the corresponding entries in it. If see entries that look appealing to me, I’ll note their in/out walkforward periods so that I can refer back to them when I run the walkforward test again.

Corresponding entries in IS/OOS Walkforward Details report:



Walkforward Metrics | IS/OOS Walkforward Averages | IS/OOS Walkforward Averages Detail

Filtered Report in Spreadsheet | Filtered items: 3

Full Report in Spreadsheet | Total items: 136

This report is the detailed version of the IS/OOS Walkforward Averages report. It expands each item in the Aver periods that comprised that average. This report can be used to help identify the exact in/out walkforward to trad column will open the STRATEGY CODE containing the optimized strategy. Copy that code to a new strategy in

Group ID	Symbol Data1	Interval Data1	Session Name	Anchored	Fitness Function	EL Code File	In/Out Period	IS Begin Date	IS End Date	IS Net Profit	IS R^2
4	CL	360min	Regular Session	Unanchored	Net Profit	My S...	504/252	01-01-2007	04-28-2018	$143,348	0.938930
4	CL	360min	Regular Session	Unanchored	Net Profit	My S...	504/126	01-01-2007	04-28-2018	$149,005	0.954690
4	CL	360min	Regular Session	Unanchored	Net Profit	My S...	504/63	01-01-2007	04-28-2018	$136,438	0.942150

If I am fortunate, I may have several different markets and time frames written down in my notes.

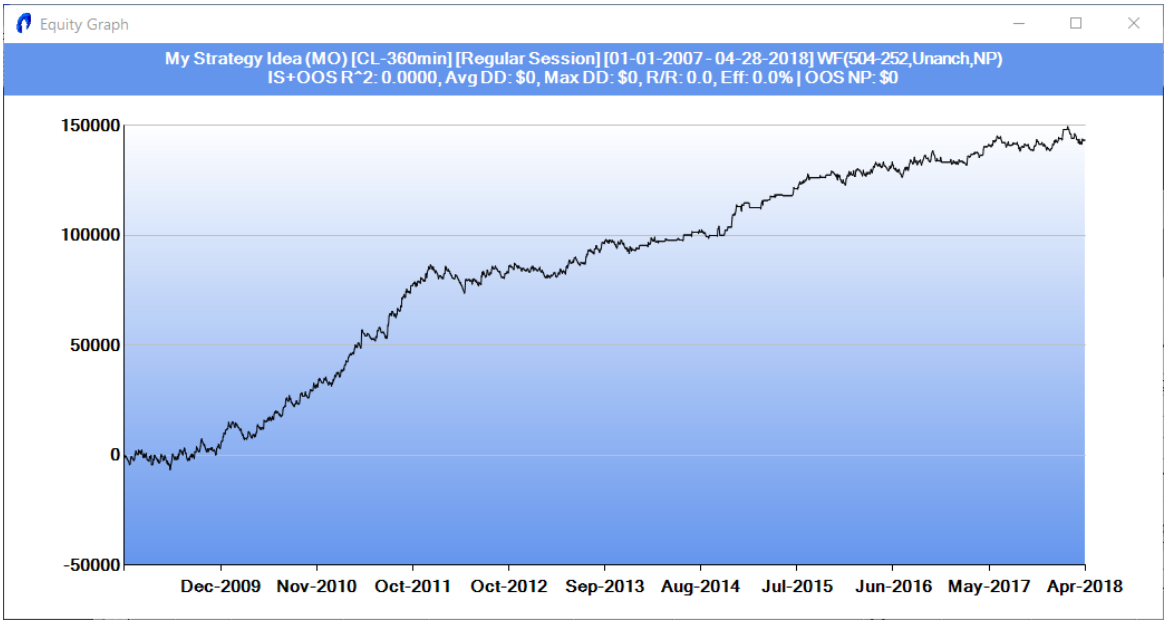
Also, I have learned that it does not always pay to choose the best walkforward for trading. Rarely have such choices worked out for me in real-time. Instead, I choose a walkforward that hovers around the average – this simply helps me avoid choosing the "best" walkforward.

So, as a matter of rule, I will immediately discount the highest in/out period (504/126 in this case).

That leave's two choices – 504/252 and 504/63. The metrics of the various parameters (Monte Carlo, Net Profit, Return/MaxDD , etc) were all very close. So there was no obvious choice here. I don't like managing frequent optimizations, so 504/252 is more appealing to me than 504/63 for purely logistic reasons.

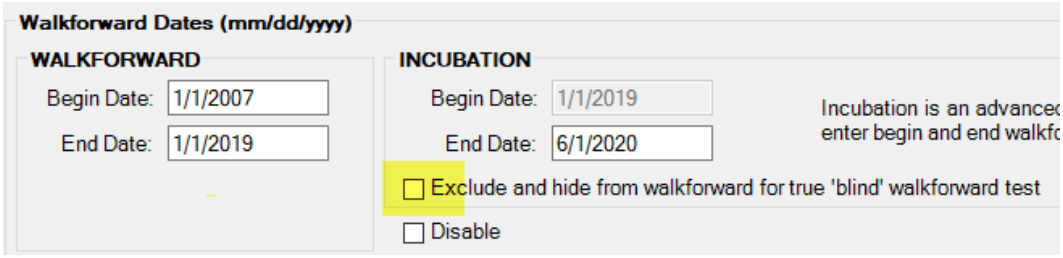
So I chose 504/252.

Remember, this was "sight unseen" before running the out-of-sample/incubation period. The equity graph of this choice looks like this:

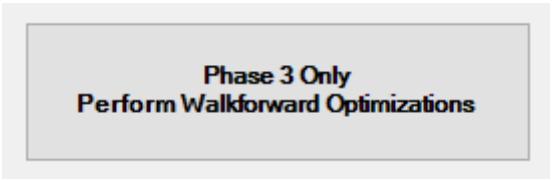


Comparing Simulated Pre-incubation and Incubation Results

It is now time to see how our walkforward selections performed. I return to the Walkforward Settings screen and uncheck the "Exclude option" so that the out-of-sample/incubation time period will be included in the walkforward.

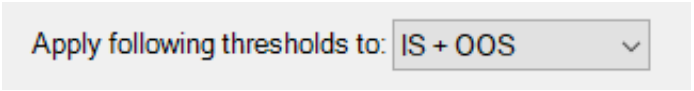


And then run walkforward/phase 3 again:



Once that is complete, we return to the *IS/OOS Walkforward Averages* report and compare in-sample with out-of-sample/incubation results. We are looking for either an improvement or, in the least, similar incubation performance metrics as we had with the pre-incubation time period.

First, we change the filter to apply to the incubation/out-of-sample results and (hopefully) our targeted walkforward group will still be in the list:



There are two reports to look at when reviewing incubation performance.

IS/OOS Walkforward Averages Report

The last few columns in this report tells us just how many of the in/out periods were the same or actually improved during the out-of-sample period. Anything above 50% is good. This means that at least 50% of the in/out periods remained the same or improved.

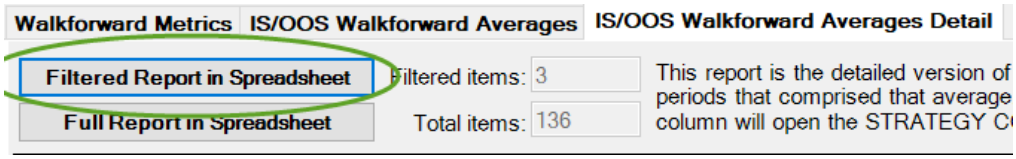
Percent In/Out's where OOS makes money (NP > 0)	Percent In/Out's where OOS R^2 same or better	Percent In/Out's where OOS Return/Max DD same or better	Percent In/Out's where OOS WF Efficiency same or better
100.00%	50.00%	75.00%	63.00%

Remember that this report tells us how all the in/out periods performed *as a group*. In our example, there were 8 in/out periods in the group. All of them made money, 4 of them had better upward slopes (R^2), 6 of them had better Return/Max Drawdown and 5 of them had better walkforward efficiency.

IS/OOS Walkforward Averages Detail Report

This report allows us to analyze the individual results for each in/out period. We are most interested in the in/out that we "blindly" selected before running the out-of-sample period: 504/252.

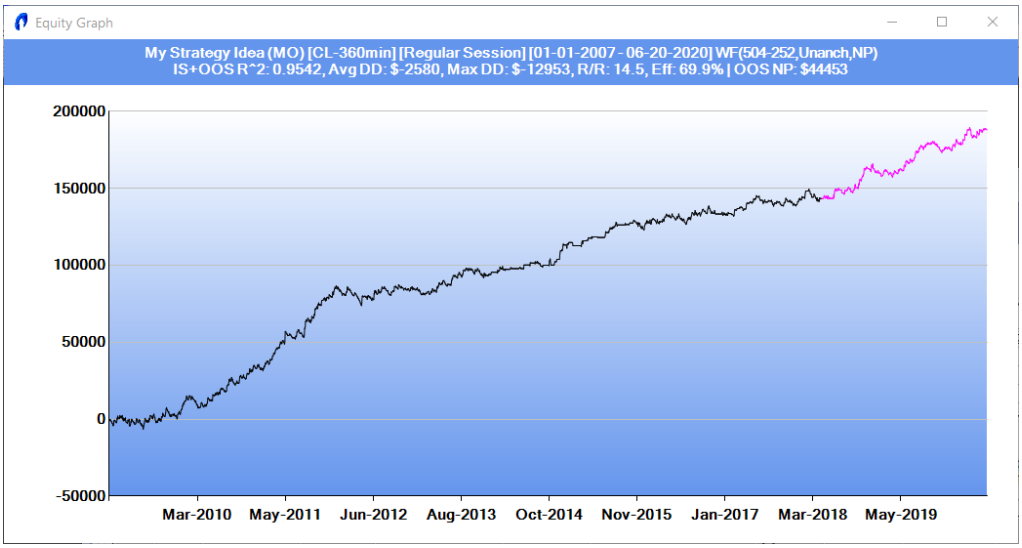
For this comparison, I'm going to open the filtered report in Excel so that I can copy-and-paste the IS and IS+OOS cells so they "stack" – Pre-incubation (in-sample) results above and Incubation (out-of-sample) results below.



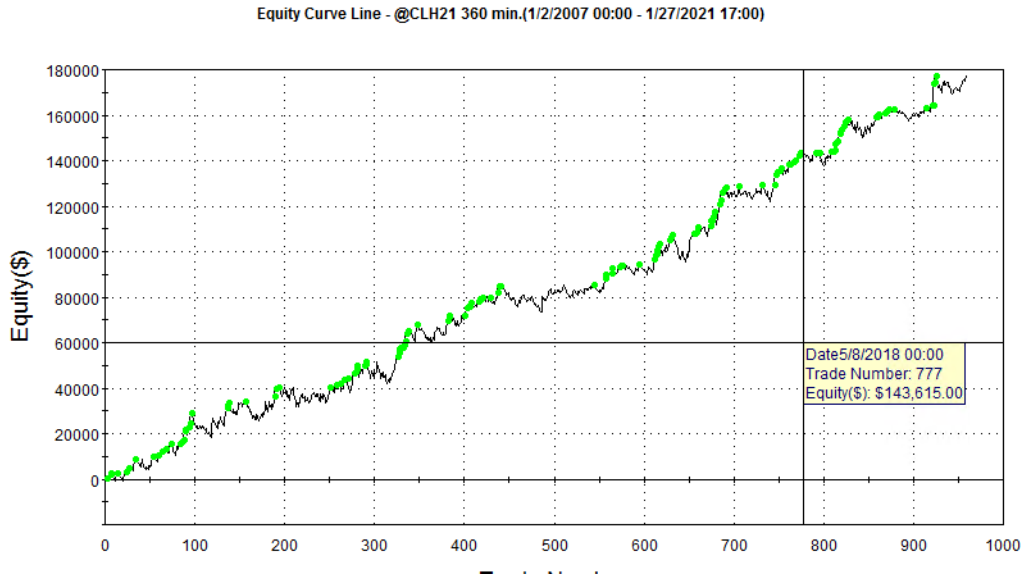
In/Out Period	IS Begin Date	IS End Date	IS Net Profit	IS R^2	IS Return/Max DD	IS Return/Avg DD	IS WF Efficiency	IS Max Run Up	IS Max DD	IS Avg DD	IS Monte Carlo	IS Annualized Net Profit	IS Annualized Return/Avg DD	IS Est. Total Trades
504/252	1/1/2007	4/28/2018	143347.5	0.93893	11.07	57.05	0.6229	155942.5	-12952.5	-2512.5	2.66	15466.11	6.16	853
	OOS Begin Date	OOS End Date	IS+OOS Net Profit	IS+OOS R^2	IS+OOS Return/Max DD	IS+OOS Return/Avg DD	IS+OOS WF Efficiency	IS+OOS Max Run Up	IS+OOS Max DD	IS+OOS Avg DD	IS+OOS Monte Carlo	IS+OOS Annualized Net Profit	IS+OOS Annualized Return/Avg DD	IS+OOS Est. Total Trades
	1/1/2007	6/20/2020	187800	0.9542	14.5	72.79	0.6992	195955	-12952.5	-2579.89	2.92	16449.96	6.38	1054
Difference:			44452.5	0.01527	3.43	15.74	0.0763	40012.5	0	-67.39	0.26	983.85	0.22	201

As you can see, there were performance increases across the board for this strategy.

The equity graph confirms this. The black line is the in-sample period and the pink line is the out-of-sample incubation period.



This example is actually a live strategy trading today. It was submitted to the Stategy Factory Club May 2018. Current real-time results as of January 2021 are:



This completes the entire analysis and selection process of a strategy!

Cross-Market Verification

As I was testing MultiOpt, I used one of my previous intermarket strategies. This is a good example of cross-market verification. While it is generally not possible to find a strategy that performs well across different symbols, it is possible to compare against other like-symbols in a sector. I created this strategy on @US. Here are the results on other interest rate markets:

Walkforward Metrics | IS/OOS Walkforward Averages | IS/OOS Walkforward Averages Detail

Filtered Report in Spreadsheet | Filtered items: 40

Full Report in Spreadsheet | Total items: 64

This report is the detailed version of the IS/OOS Walkforward Averages report. It expands each item in the Averages Report into the separate in/out periods that comprised that average. This report can be used to help identify the exact in/out walkforward to trade in real-time. Clicking 'EL Code File' column will open the STRATEGY CODE containing the optimized strategy. Copy that code to a new strategy in TradeStation for real-time trading.

Group ID	Symbol Data1	Interval Data1	Symbol Data2	Interval Data2	Symbol Data3	Interval Data3	Session Name	Anchored	Fitness Function	EL Code File	In/Out Period	IS Begin Date	IS End Date	IS Net Profit	IS R^2	IS Return/DD
13	US	1440min	HG	1440min	$UTY	1440min	Regular Session	Anchored	Net Profit	SFC-...	252/252	01-01-2008	01-01-2017	$65,622	0.908850	5.53
13	US	1440min	HG	1440min	$UTY	1440min	Regular Session	Anchored	Net Profit	SFC-...	252/126	01-01-2008	01-01-2017	$59,973	0.872100	5.16
13	US	1440min	HG	1440min	$UTY	1440min	Regular Session	Anchored	Net Profit	SFC-...	504/252	01-01-2008	01-01-2017	$54,403	0.875130	4.58
13	US	1440min	HG	1440min	$UTY	1440min	Regular Session	Anchored	Net Profit	SFC-...	126/63	01-01-2008	01-01-2017	$64,574	0.848280	5.56
13	US	1440min	HG	1440min	$UTY	1440min	Regular Session	Anchored	Net Profit	SFC-...	126/126	01-01-2008	01-01-2017	$63,994	0.886860	5.51
13	US	1440min	HG	1440min	$UTY	1440min	Regular Session	Anchored	Net Profit	SFC-...	252/63	01-01-2008	01-01-2017	$54,879	0.820570	4.72
13	US	1440min	HG	1440min	$UTY	1440min	Regular Session	Anchored	Net Profit	SFC-...	504/126	01-01-2008	01-01-2017	$48,753	0.834300	4.20
1	FV	1440min	HG	1440min	$UTY	1440min	Regular Session	Anchored	Net Profit	SFC-...	504/252	01-01-2008	01-01-2017	$13,875	0.916590	4.27
1	FV	1440min	HG	1440min	$UTY	1440min	Regular Session	Anchored	Net Profit	SFC-...	252/252	01-01-2008	01-01-2017	$15,310	0.930800	4.71
14	US	1440min	HG	1440min	$UTY	1440min	Regular Session	Unanchored	Net Profit	SFC-...	252/252	01-01-2008	01-01-2017	$45,726	0.928820	3.74
14	US	1440min	HG	1440min	$UTY	1440min	Regular Session	Unanchored	Net Profit	SFC-...	126/63	01-01-2008	01-01-2017	$49,222	0.708340	3.10
13	US	1440min	HG	1440min	$UTY	1440min	Regular Session	Anchored	Net Profit	SFC-...	504/63	01-01-2008	01-01-2017	$43,659	0.779570	3.76
10	TY	1440min	HG	1440min	$UTY	1440min	Regular Session	Unanchored	Net Profit	SFC-...	252/252	01-01-2008	01-01-2017	$24,216	0.808570	4.36
14	US	1440min	HG	1440min	$UTY	1440min	Regular Session	Unanchored	Net Profit	SFC-...	126/126	01-01-2008	01-01-2017	$48,066	0.839330	2.98
14	US	1440min	HG	1440min	$UTY	1440min	Regular Session	Unanchored	Net Profit	SFC-...	252/126	01-01-2008	01-01-2017	$43,626	0.887170	3.56
1	FV	1440min	HG	1440min	$UTY	1440min	Regular Session	Anchored	Net Profit	SFC-...	126/63	01-01-2008	01-01-2017	$15,530	0.955350	4.78
14	US	1440min	HG	1440min	$UTY	1440min	Regular Session	Unanchored	Net Profit	SFC-...	252/63	01-01-2008	01-01-2017	$41,117	0.902070	3.23
1	FV	1440min	HG	1440min	$UTY	1440min	Regular Session	Anchored	Net Profit	SFC-...	252/63	01-01-2008	01-01-2017	$13,951	0.949330	4.29
1	FV	1440min	HG	1440min	$UTY	1440min	Regular Session	Anchored	Net Profit	SFC-...	504/63	01-01-2008	01-01-2017	$11,906	0.939100	3.66
10	TY	1440min	HG	1440min	$UTY	1440min	Regular Session	Unanchored	Net Profit	SFC-...	126/63	01-01-2008	01-01-2017	$25,151	0.843570	3.70
10	TY	1440min	HG	1440min	$UTY	1440min	Regular Session	Unanchored	Net Profit	SFC-...	252/63	01-01-2008	01-01-2017	$21,881	0.734770	3.18

As you can see, this @US strategy performed well in similar markets (@TY and @FV), making a nice robustness check for the strategy!