

Machine Learning Report: 09/06/2018

10Y Treasuries: buy/sell signal for 5-day trade horizon

Contents	Page
Tradingsignal	1
Table 1: Current recommended direction, conviction level and relative sizing for average top 5 strategies	
Figure 1: Sharpe ratio for top 5 strategies	
Figure 2: Residual Sharpe at 95% level for top 5 strategies	
Tradingsignal	2
Table 1: Current recommended direction, conviction level and relative sizing for top 5 strategies	
Appendix – Individual algorithm performance measurement	
GBM Balanced	3
Figure 1: Top 5 strategies Sharpe vs Benchmark	
Figure 2: Top 5 strategies average hit rate vs conviction	
Figure 3: Top 5 strategies average Sharpe by rally/sell-off	
Figure 4: Top 5 strategies rolling 1Y hit rate	
Figure 5: Top 5 strategies rolling 1Y sell fraction	
Figure 6: Top 5 strategies rolling 1Y Sharpe ratio	
GBM None	4
RF Balanced	5
RF None	6
SVM Linear Balanced	7
SVM Linear None	8
SVM RBF Balanced	9
SVM RBF None	10

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Quarantine Period: 01/03/2017 to 08/28/2018; Cross Validation Period: 01/03/2008 to 12/31/2016

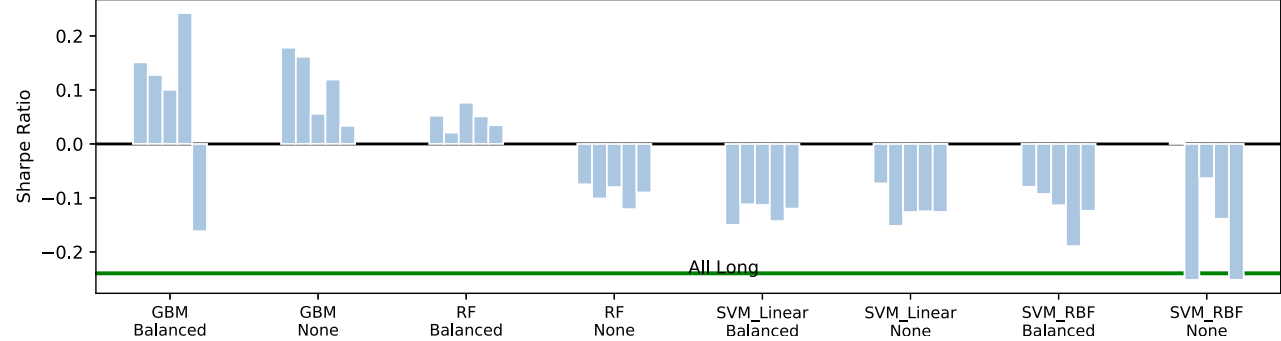
Table 1: Current recommended direction, conviction level and relative sizing for average top 5 strategies

			Recommended Direction				Conviction*				Size*			
			Today	Yesterday	1w ago	1m ago	Today	Yesterday	1w ago	1m ago	Today	Yesterday	1w ago	1m ago
Weight	Algo	Rank												
Balanced	GBM	Avg	buy	buy	buy	buy	53%	51%	69%	68%	0.06	0.01	0.38	0.36
	RF	Avg	buy	buy	buy	buy	52%	52%	58%	58%	0.05	0.04	0.15	0.15
	SVM_Linear	Avg	buy	buy	buy	buy	71%	62%	74%	73%	0.42	0.23	0.49	0.46
	SVM_RBF	Avg	buy	sell	buy	buy	65%	51%	64%	70%	0.3	-0.01	0.27	0.41
None	GBM	Avg	buy	buy	buy	buy	55%	52%	76%	75%	0.1	0.04	0.52	0.49
	RF	Avg	buy	buy	buy	buy	58%	57%	63%	63%	0.15	0.15	0.25	0.25
	SVM_Linear	Avg	buy	buy	buy	buy	74%	65%	76%	74%	0.49	0.31	0.52	0.48
	SVM_RBF	Avg	buy	buy	buy	buy	72%	53%	72%	74%	0.45	0.06	0.45	0.49

Note: We include signals produced by Gradient Boosting Machine (GBM), Random Forest (RF), and Support Vector Machines (SVM) with Linear and Radial Basis Function (RBF) kernels. Balanced refers to equal weight across label class (buy/sell) and None has no class weight. Hyperparameter tuning based on a 5-fold cross validation during period defined above. Trained classifiers held constant over quarantine. Top 5 based on the higher Sharpe ratio in cross-validation. Average is the soft voting result of the top 5.

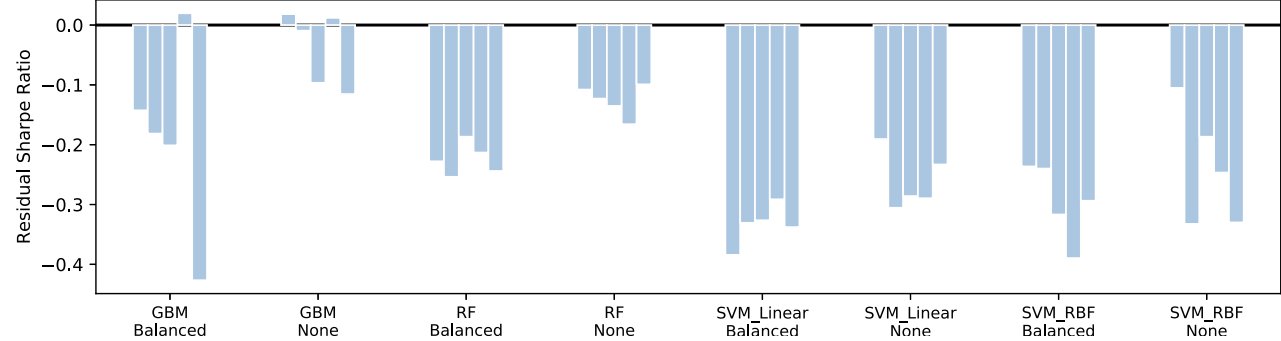
* Conviction is the probability of a given signal estimated by the trained classifier. Sizes assume the Kelly criterion of $(-1 + 2 * p)$.

Figure 1: Sharpe ratio for top 5 strategies



Note: Figure 1 includes annualized Sharpe Ratio of top 5 strategies by algorithms over the Quarantine period. The Sharpe ratio of All Long* strategy is presented as a solid green horizontal line for benchmark. * All Long is the performance from uniform buy daily.

Figure 2: Residual Sharpe* at 95% Level for top 5 strategies



Note: Figure 2 includes Residual Sharpe* of top 5 strategies by algorithms over the Quarantine period.

* Residual Shape is defined as the difference between the actual Sharpe from a given trained classifier and the 95th percentile outcome after randomly permuting daily trading signals over the Quarantine period. A positive residual represents a statistically significant improvement.

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			Today	Yesterday	1w ago	1m ago	Today	Yesterday	1w ago	1m ago	Today	Yesterday	1w ago	1m ago
Weight	Algo	Rank												
Balanced	GBM	1	buy	buy	buy	buy	54%	51%	70%	67%	0.08	0.02	0.4	0.35
		2	buy	buy	buy	buy	55%	51%	70%	67%	0.09	0.02	0.4	0.34
		3	buy	buy	buy	buy	53%	51%	68%	66%	0.05	0.01	0.36	0.32
		4	sell	sell	buy	buy	52%	54%	73%	71%	-0.03	-0.08	0.46	0.41
		5	buy	buy	buy	buy	54%	55%	64%	69%	0.09	0.1	0.27	0.37
	RF	1	buy	buy	buy	buy	52%	52%	57%	58%	0.05	0.04	0.15	0.15
		2	buy	buy	buy	buy	52%	52%	57%	57%	0.05	0.03	0.14	0.14
		3	buy	buy	buy	buy	52%	51%	57%	57%	0.04	0.03	0.15	0.15
		4	buy	buy	buy	buy	52%	52%	57%	57%	0.05	0.04	0.14	0.14
		5	buy	buy	buy	buy	53%	53%	59%	59%	0.06	0.06	0.19	0.18
	SVM_Linear	1	buy	buy	buy	buy	71%	61%	74%	72%	0.43	0.23	0.47	0.44
		2	buy	buy	buy	buy	70%	60%	74%	72%	0.41	0.2	0.47	0.44
		3	buy	buy	buy	buy	70%	60%	74%	72%	0.41	0.2	0.47	0.44
		4	buy	buy	buy	buy	74%	66%	77%	77%	0.48	0.33	0.55	0.54
		5	buy	buy	buy	buy	70%	60%	73%	72%	0.41	0.2	0.47	0.44
	SVM_RBF	1	buy	sell	buy	buy	64%	51%	61%	70%	0.28	-0.01	0.22	0.4
		2	buy	sell	buy	buy	66%	51%	63%	72%	0.32	-0.02	0.25	0.44
		3	buy	sell	buy	buy	65%	50%	67%	70%	0.31	-0	0.34	0.39
		4	buy	sell	buy	buy	66%	50%	68%	70%	0.31	-0	0.36	0.41
		5	buy	sell	buy	buy	63%	51%	60%	69%	0.26	-0.03	0.21	0.39
None	GBM	1	sell	sell	buy	buy	52%	57%	79%	80%	-0.04	-0.13	0.58	0.6
		2	sell	sell	buy	buy	52%	55%	77%	79%	-0.04	-0.1	0.54	0.59
		3	buy	buy	buy	buy	60%	56%	75%	72%	0.19	0.12	0.5	0.43
		4	buy	buy	buy	buy	59%	59%	73%	70%	0.19	0.18	0.47	0.4
		5	buy	buy	buy	buy	60%	55%	76%	72%	0.2	0.1	0.51	0.44
	RF	1	buy	buy	buy	buy	57%	57%	62%	63%	0.15	0.14	0.25	0.25
		2	buy	buy	buy	buy	57%	57%	62%	62%	0.15	0.14	0.24	0.24
		3	buy	buy	buy	buy	58%	58%	64%	64%	0.16	0.15	0.28	0.27
		4	buy	buy	buy	buy	58%	58%	63%	63%	0.17	0.16	0.26	0.26
		5	buy	buy	buy	buy	58%	57%	62%	62%	0.15	0.14	0.24	0.24
	SVM_Linear	1	buy	buy	buy	buy	79%	72%	81%	79%	0.58	0.43	0.63	0.58
		2	buy	buy	buy	buy	72%	62%	73%	72%	0.43	0.23	0.45	0.43
		3	buy	buy	buy	buy	72%	62%	74%	72%	0.44	0.23	0.48	0.43
		4	buy	buy	buy	buy	72%	62%	74%	72%	0.44	0.23	0.48	0.43
		5	buy	buy	buy	buy	77%	70%	79%	77%	0.55	0.4	0.57	0.54
	SVM_RBF	1	buy	buy	buy	buy	75%	56%	76%	76%	0.5	0.12	0.52	0.52
		2	buy	buy	buy	buy	71%	51%	70%	73%	0.42	0.03	0.41	0.47
		3	buy	buy	buy	buy	73%	54%	74%	75%	0.46	0.08	0.47	0.5
		4	buy	buy	buy	buy	72%	53%	71%	74%	0.43	0.07	0.42	0.48
		5	buy	buy	buy	buy	71%	51%	70%	73%	0.42	0.03	0.41	0.47

Note: This is a detailed version of Table 1 on the first page, top 5 strategies' individual decisions are included.

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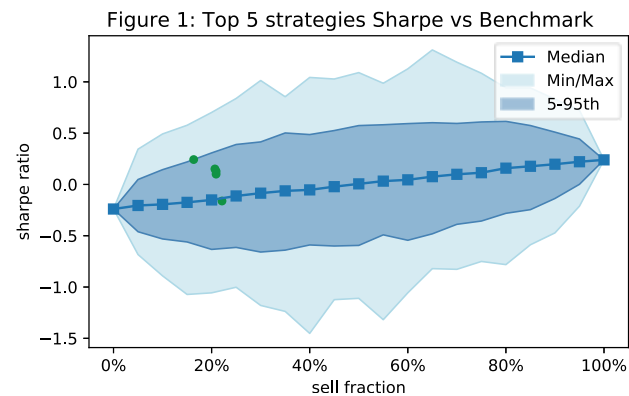
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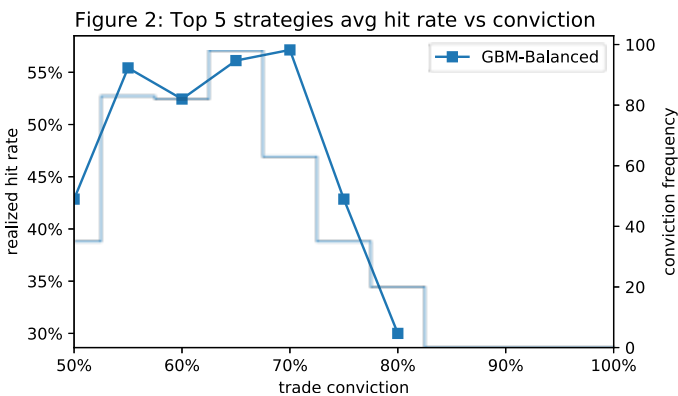
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10Y Treasuries: Top 5 GBM-Balanced performance measurement

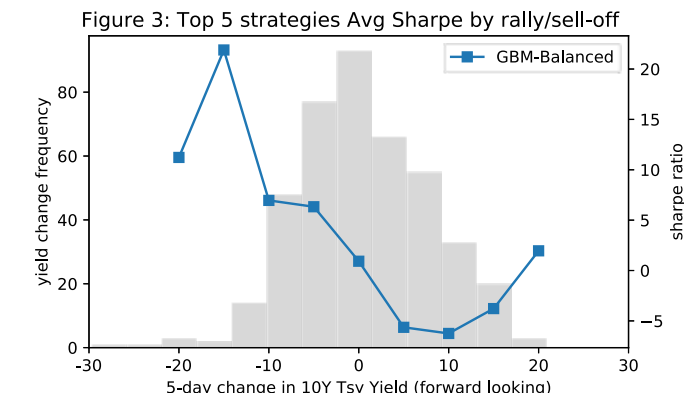
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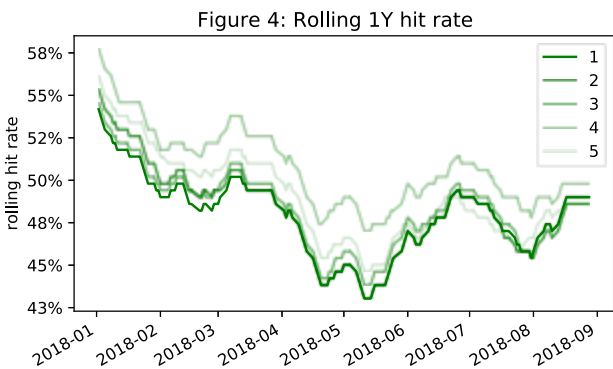
Note: Figure 1 compares top 5 strategies' Sharpe ratio (unitless) presented as green dots with percentiles of random trading decisions' Sharpe over Quarantine. Percentiles come from 1000 trials randomly permuting daily trading decisions at a fixed percentage of sell days (sell fraction) and then calculating Sharpe ratio for each trial.



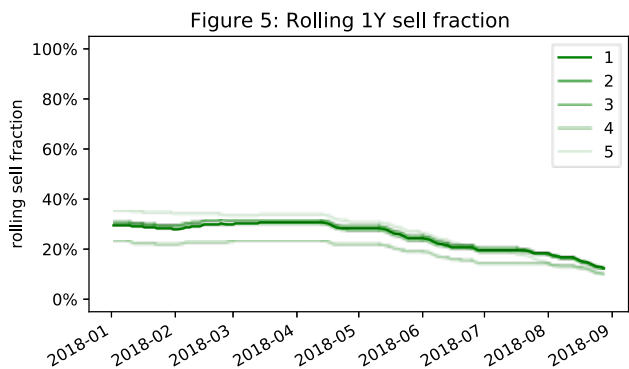
Note: Figure 2 presents top 5 strategies' average hit rate by different conviction/confidence level over Quarantine. Hit rate (LHS; %) is broken out by the classifier's confidence (x-axis; %) in the signal at trade inception; it also provides the distribution of trading days by confidence within each group (RHS; counts).



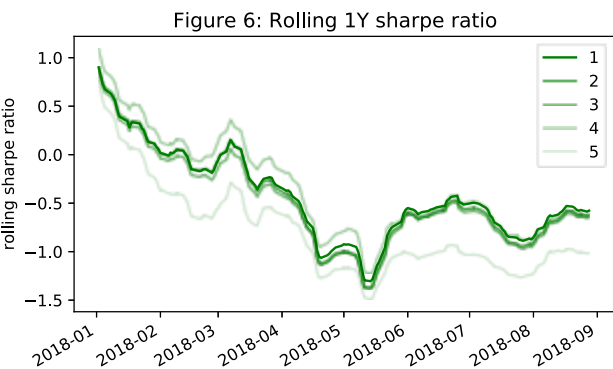
Note: Figure 3 presents average of top 5 strategies' Sharpe ratio (RHS; unitless) broken out by yield change (x-axis; bps) over Quarantine. Overlaid is the frequency of 5-day yield moves (LHS; counts).



Note: Figure 4 presents top 5 strategies' rolling 1 year hit rate (%) over Quarantine.



Note: Figure 5 presents top 5 strategies' rolling 1 year sell fraction (%) over Quarantine.



Note: Figure 6 presents top 5 strategies' rolling 1 year Sharpe ratio (unitless) over Quarantine.

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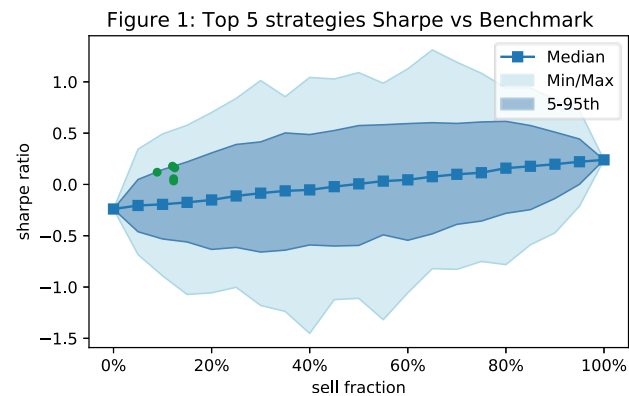
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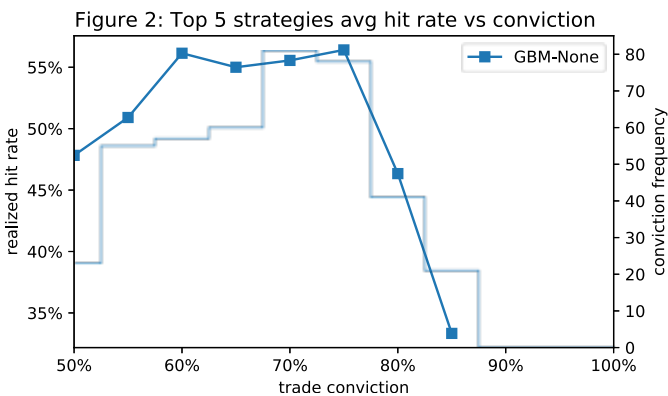
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10Y Treasuries: Top 5 GBM-None performance measurement

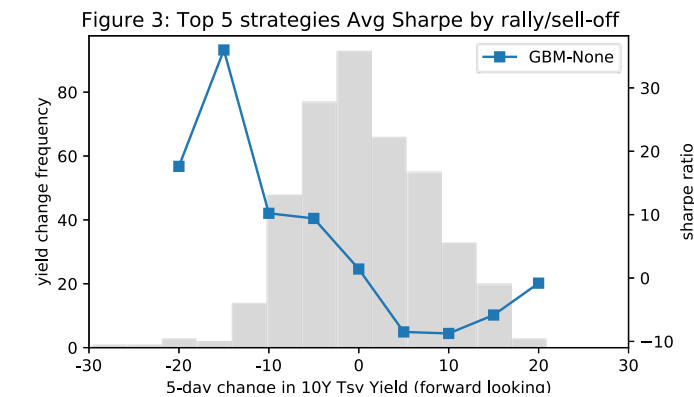
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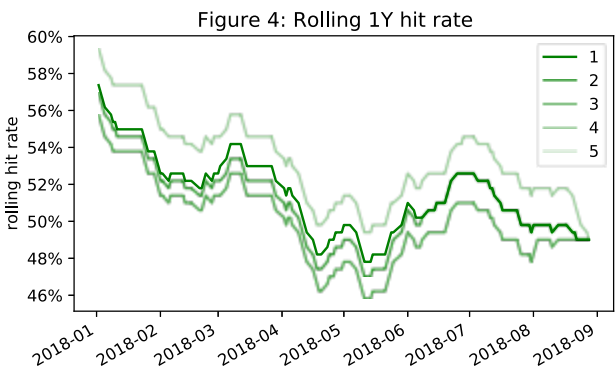
Note: Figure 1 compares top 5 strategies' Sharpe ratio (unitless) presented as green dots with percentiles of random trading decisions' Sharpe over Quarantine. Percentiles come from 1000 trials randomly permuting daily trading decisions at a fixed percentage of sell days (sell fraction) and then calculating Sharpe ratio for each trial.



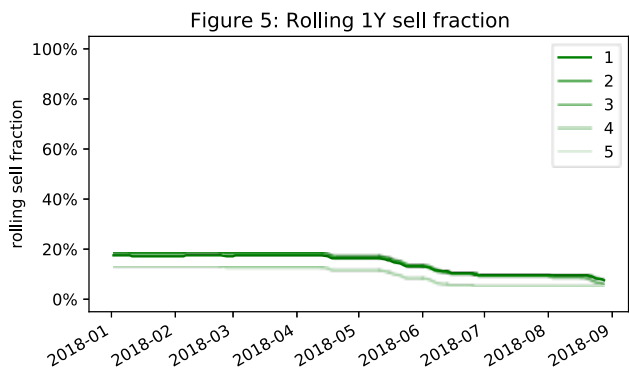
Note: Figure 2 presents top 5 strategies' average hit rate by different conviction/confidence level over Quarantine. Hit rate (LHS; %) is broken out by the classifier's confidence (x-axis; %) in the signal at trade inception; it also provides the distribution of trading days by confidence within each group (RHS; counts).



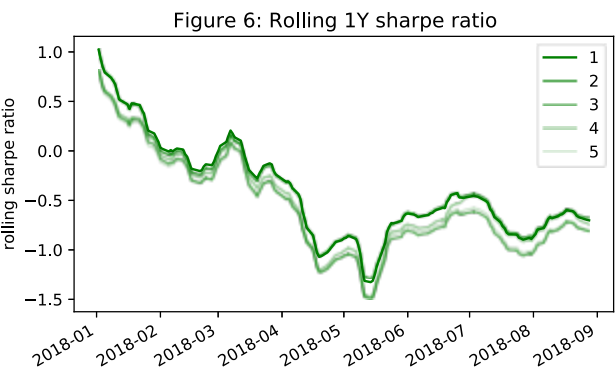
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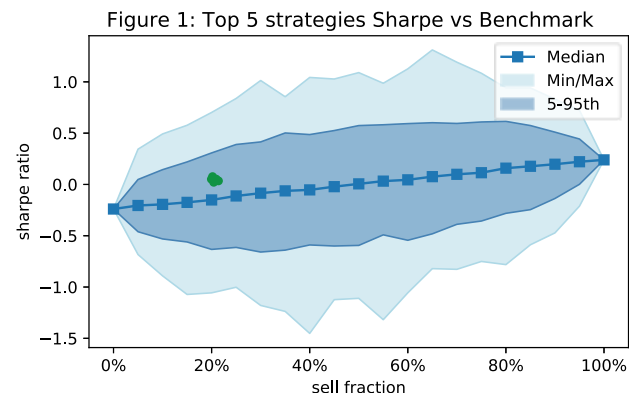
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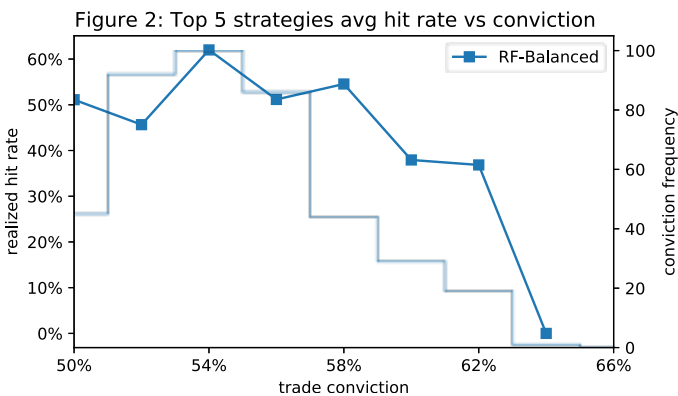
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10Y Treasuries: Top 5 RF-Balanced performance measurement

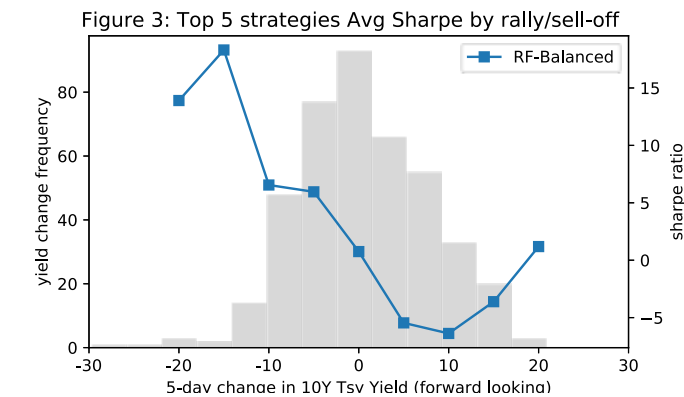
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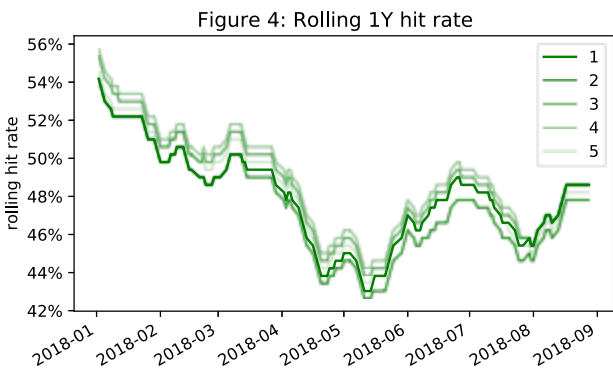
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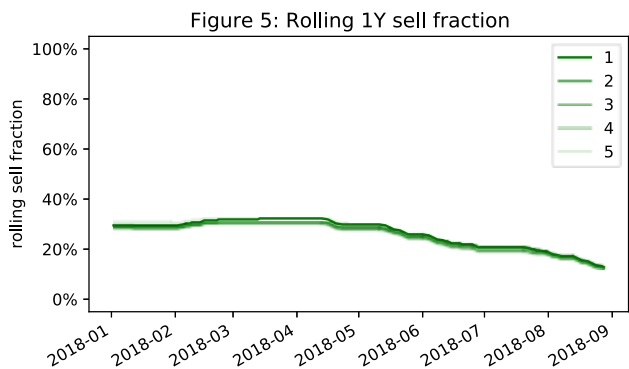
Note: Figure 2 presents top 5 strategies' average hit rate by different conviction/confidence level over Quarantine. Hit rate (LHS; %) is broken out by the classifier's confidence (x-axis; %) in the signal at trade inception; it also provides the distribution of trading days by confidence within each group (RHS; counts).



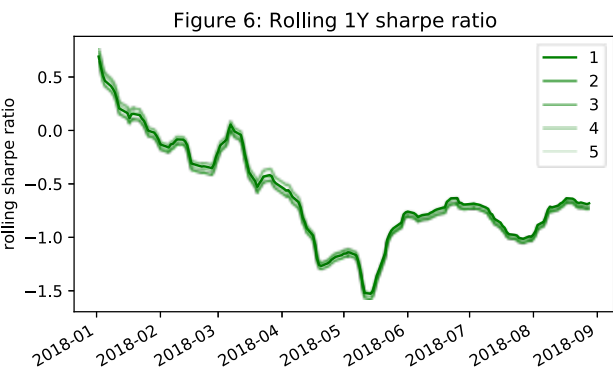
Note: Figure 3 presents average of top 5 strategies' Sharpe ratio (RHS; unitless) broken out by yield change (x-axis; bps) over Quarantine. Overlaid is the frequency of 5-day yield moves (LHS; counts).



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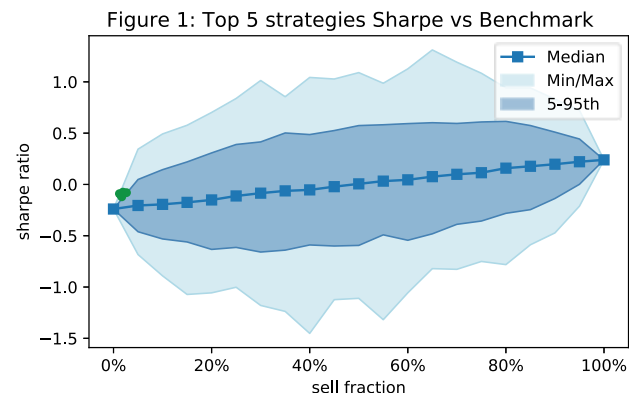
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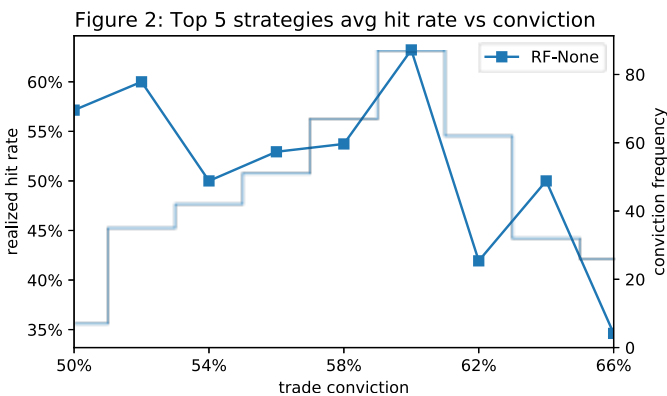
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10Y Treasuries: Top 5 RF-None performance measurement

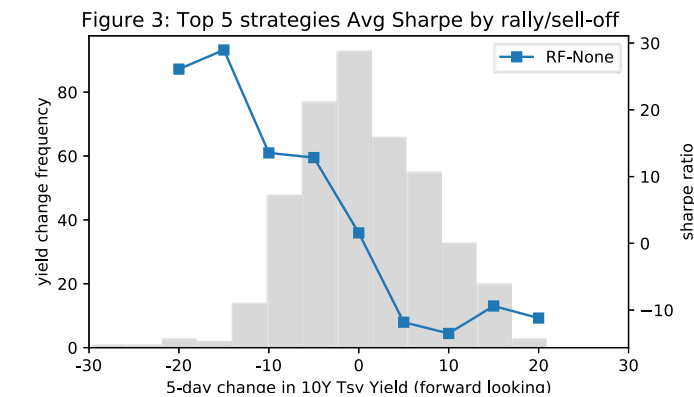
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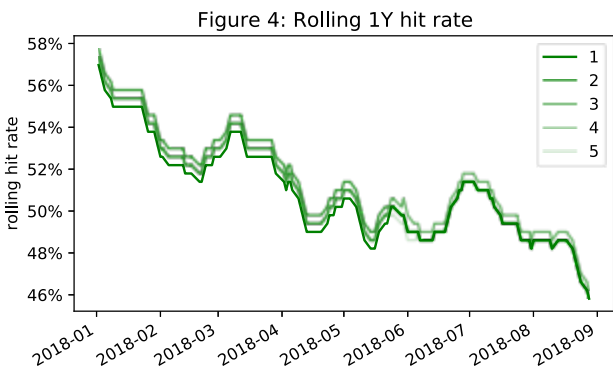
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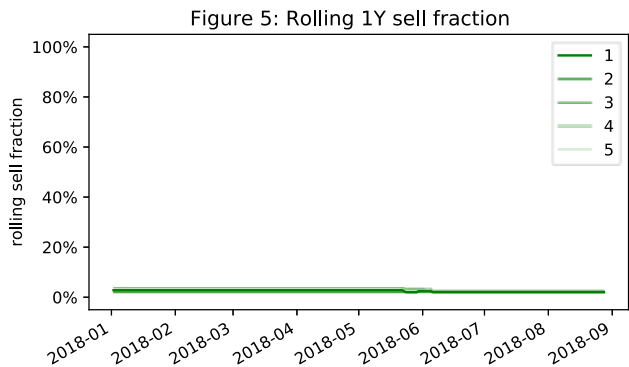
Note: Figure 2 presents top 5 strategies' average hit rate by different conviction/confidence level over Quarantine. Hit rate (LHS; %) is broken out by the classifier's confidence (x-axis; %) in the signal at trade inception; it also provides the distribution of trading days by confidence within each group (RHS; counts).



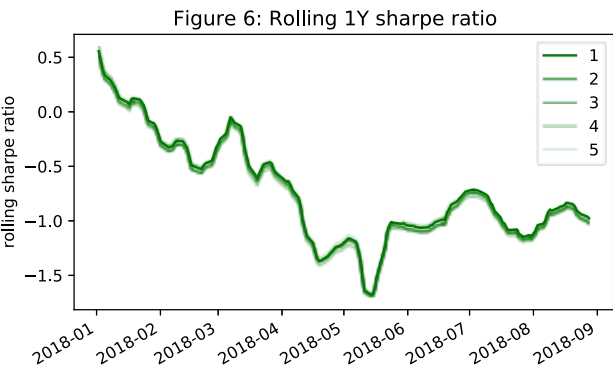
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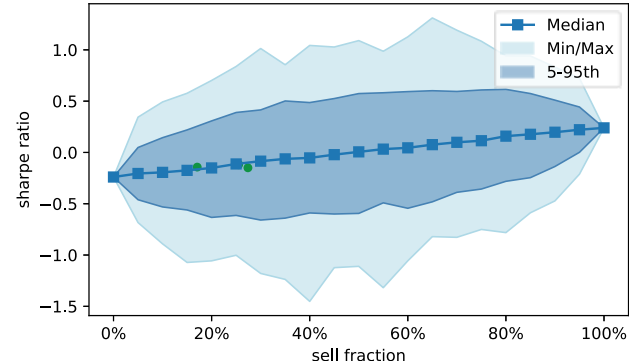
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10Y Treasuries: Top 5 SVM-Linear-Balanced performance measurement

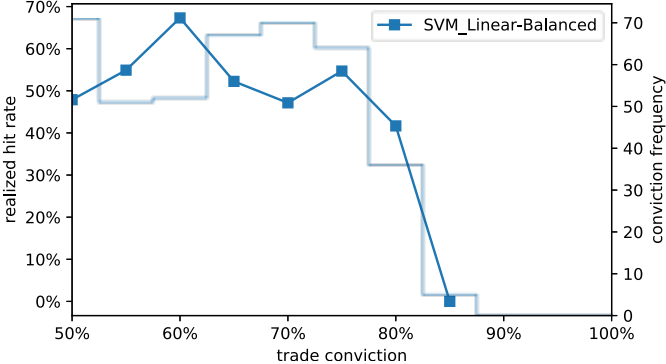
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Figure 1: Top 5 strategies Sharpe vs Benchmark



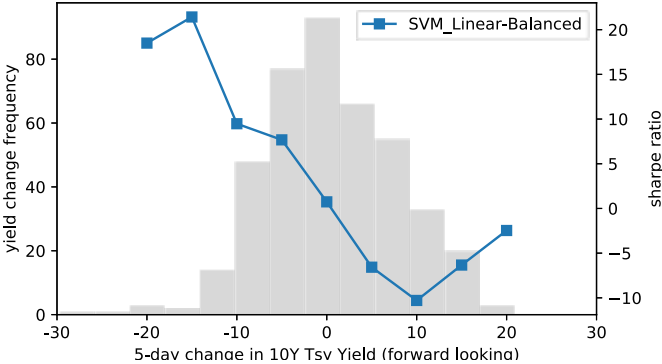
Note: Figure 1 compares top 5 strategies' Sharpe ratio (unitless) presented as green dots with percentiles of random trading decisions' Sharpe over Quarantine. Percentiles come from 1000 trials randomly permuting daily trading decisions at a fixed percentage of sell days (sell fraction) and then calculating Sharpe ratio for each trial.

Figure 2: Top 5 strategies avg hit rate vs conviction



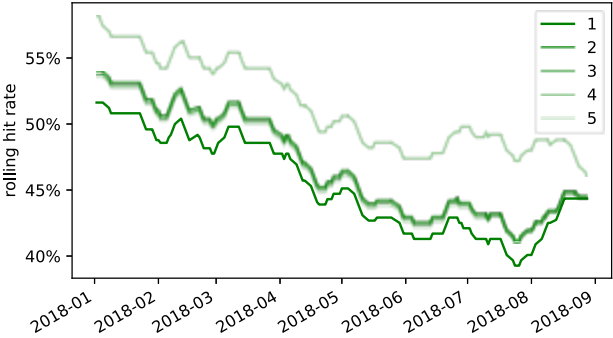
Note: Figure 2 presents top 5 strategies' average hit rate by different conviction/confidence level over Quarantine. Hit rate (LHS; %) is broken out by the classifier's confidence (x-axis; %) in the signal at trade inception; it also provides the distribution of trading days by confidence within each group (RHS; counts).

Figure 3: Top 5 strategies Avg Sharpe by rally/sell-off



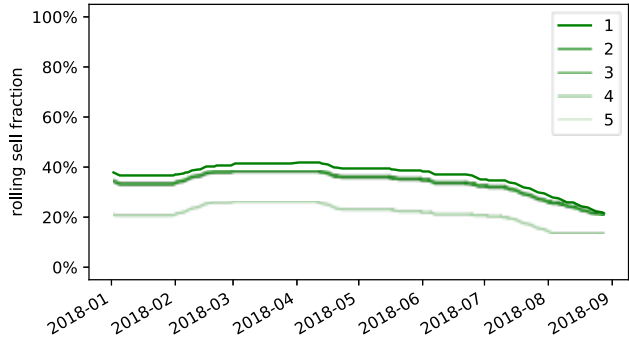
Note: Figure 3 presents average of top 5 strategies' Sharpe ratio (RHS; unitless) broken out by yield change (x-axis; bps) over Quarantine. Overlaid is the frequency of 5-day yield moves (LHS; counts).

Figure 4: Rolling 1Y hit rate



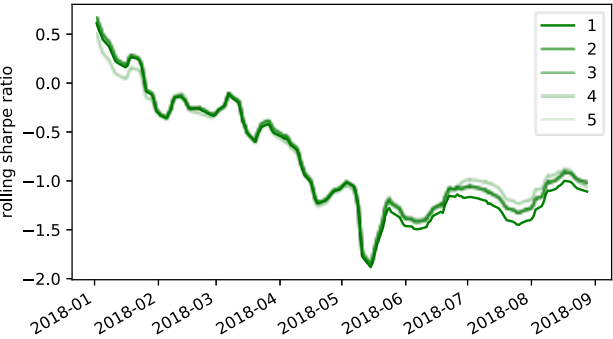
Note: Figure 4 presents top 5 strategies' rolling 1 year hit rate (%) over Quarantine.

Figure 5: Rolling 1Y sell fraction



Note: Figure 5 presents top 5 strategies' rolling 1 year sell fraction (%) over Quarantine.

Figure 6: Rolling 1Y sharpe ratio



Note: Figure 6 presents top 5 strategies' rolling 1 year Sharpe ratio (unitless) over Quarantine.

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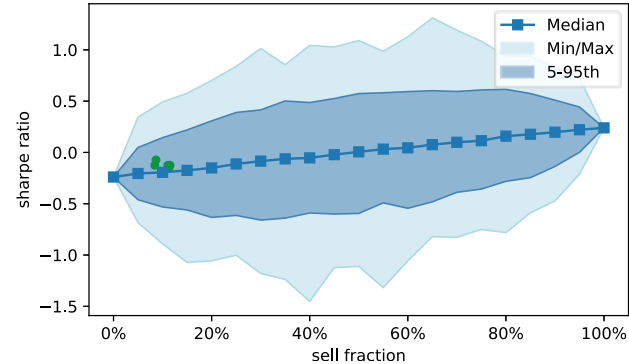
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Machine Learning Report - Appendix: 09/06/2018

10Y Treasuries: Top 5 SVM-Linear-None performance measurement

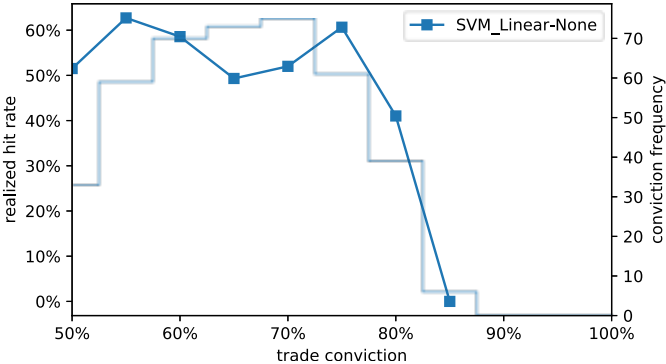
Quarantine Period: 01/03/2017 to 08/28/2018; Cross Validation Period: 01/03/2008 to 12/31/2016

Figure 1: Top 5 strategies Sharpe vs Benchmark



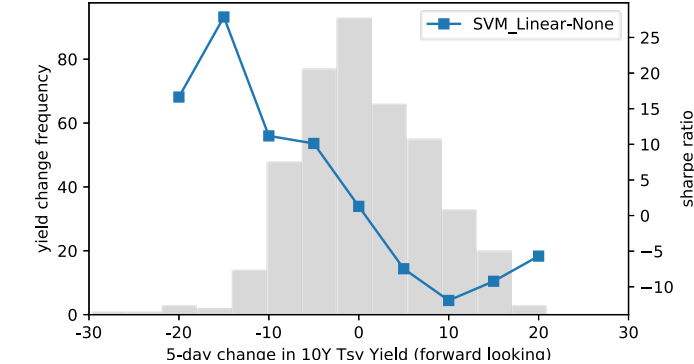
Note: Figure 1 compares top 5 strategies' Sharpe ratio (unitless) presented as green dots with percentiles of random trading decisions' Sharpe over Quarantine. Percentiles come from 1000 trials randomly permuting daily trading decisions at a fixed percentage of sell days (sell fraction) and then calculating Sharpe ratio for each trial.

Figure 2: Top 5 strategies avg hit rate vs conviction



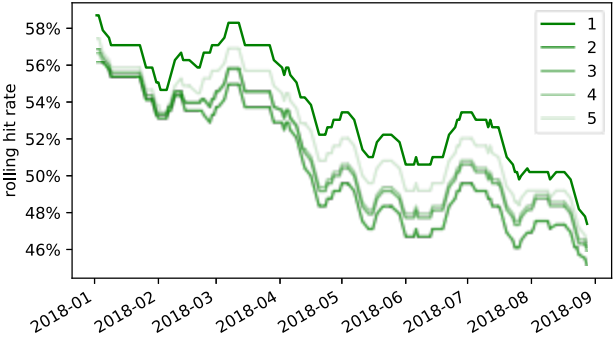
Note: Figure 2 presents top 5 strategies' average hit rate by different conviction/confidence level over Quarantine. Hit rate (LHS; %) is broken out by the classifier's confidence (x-axis; %) in the signal at trade inception; it also provides the distribution of trading days by confidence within each group (RHS; counts).

Figure 3: Top 5 strategies Avg Sharpe by rally/sell-off



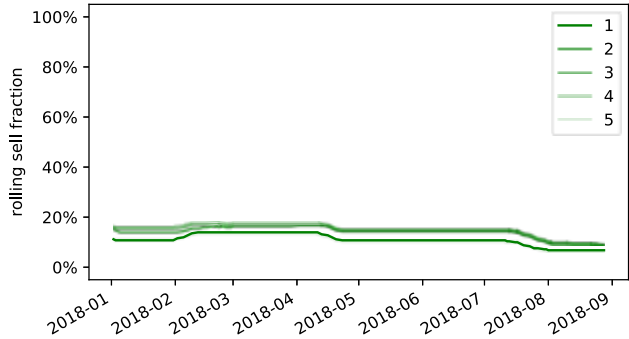
Note: Figure 3 presents average of top 5 strategies' Sharpe ratio (RHS; unitless) broken out by yield change (x-axis; bps) over Quarantine. Overlaid is the frequency of 5-day yield moves (LHS; counts).

Figure 4: Rolling 1Y hit rate



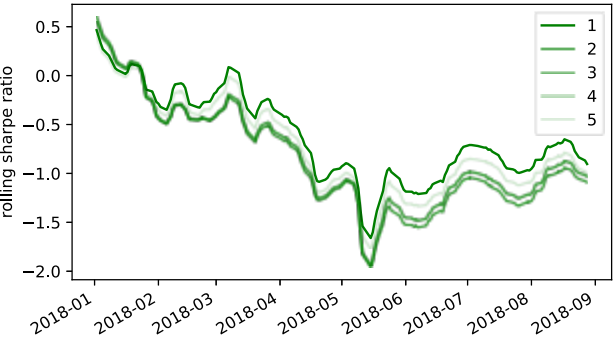
Note: Figure 4 presents top 5 strategies' rolling 1 year hit rate (%) over Quarantine.

Figure 5: Rolling 1Y sell fraction



Note: Figure 5 presents top 5 strategies' rolling 1 year sell fraction (%) over Quarantine.

Figure 6: Rolling 1Y sharpe ratio



Note: Figure 6 presents top 5 strategies' rolling 1 year Sharpe ratio (unitless) over Quarantine.

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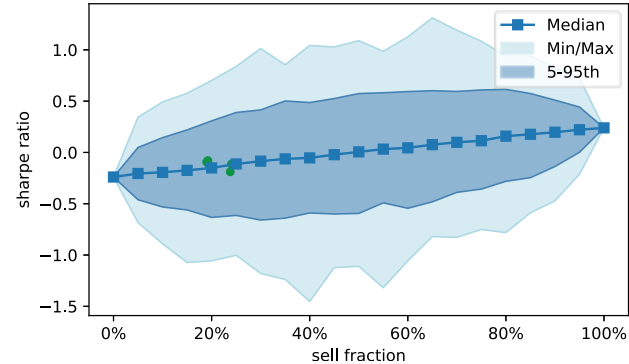
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Machine Learning Report - Appendix: 09/06/2018

10Y Treasuries: Top 5 SVM-RBF-Balanced performance measurement

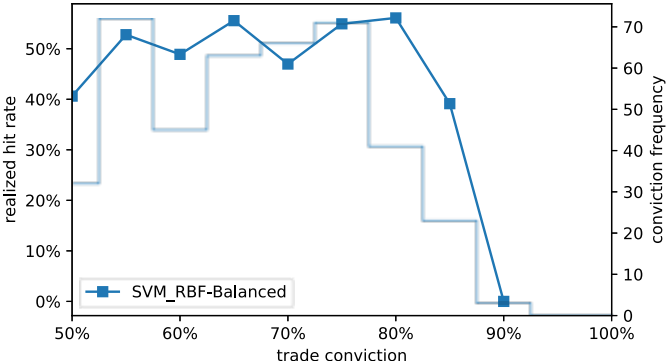
Quarantine Period: 01/03/2017 to 08/28/2018; Cross Validation Period: 01/03/2008 to 12/31/2016

Figure 1: Top 5 strategies Sharpe vs Benchmark



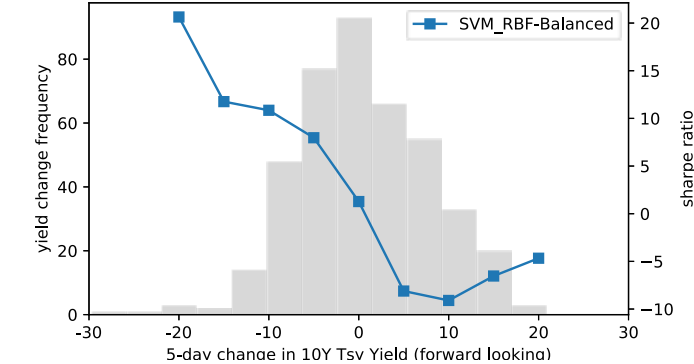
Note: Figure 1 compares top 5 strategies' Sharpe ratio (unitless) presented as green dots with percentiles of random trading decisions' Sharpe over Quarantine. Percentiles come from 1000 trials randomly permuting daily trading decisions at a fixed percentage of sell days (sell fraction) and then calculating Sharpe ratio for each trial.

Figure 2: Top 5 strategies avg hit rate vs conviction



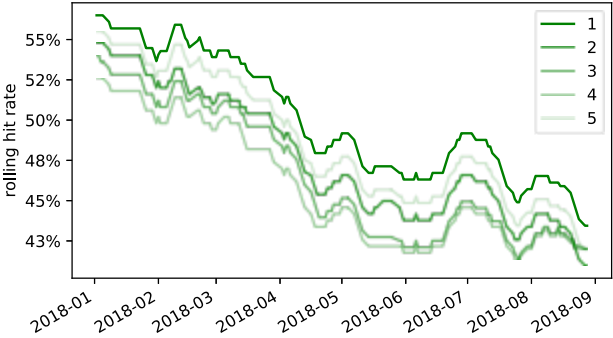
Note: Figure 2 presents top 5 strategies' average hit rate by different conviction/confidence level over Quarantine. Hit rate (LHS; %) is broken out by the classifier's confidence (x-axis; %) in the signal at trade inception; it also provides the distribution of trading days by confidence within each group (RHS; counts).

Figure 3: Top 5 strategies Avg Sharpe by rally/sell-off



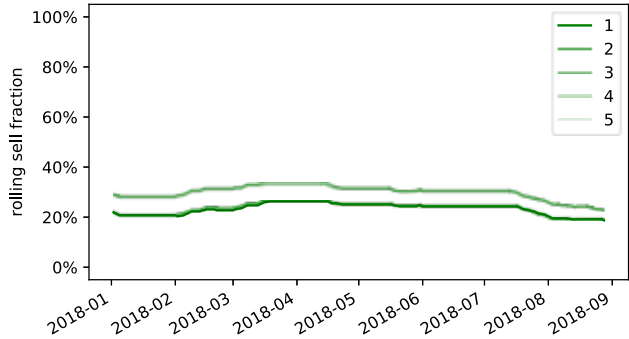
Note: Figure 3 presents average of top 5 strategies' Sharpe ratio (RHS; unitless) broken out by yield change (x-axis; bps) over Quarantine. Overlaid is the frequency of 5-day yield moves (LHS; counts).

Figure 4: Rolling 1Y hit rate



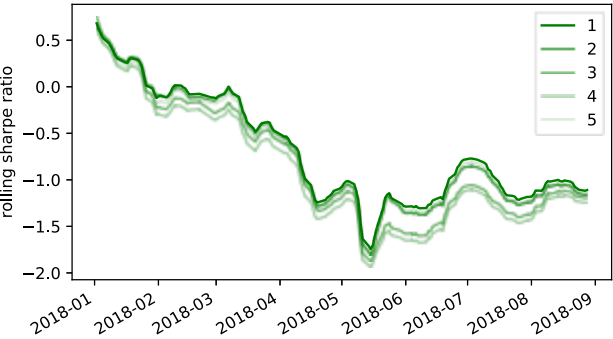
Note: Figure 4 presents top 5 strategies' rolling 1 year hit rate (%) over Quarantine.

Figure 5: Rolling 1Y sell fraction



Note: Figure 5 presents top 5 strategies' rolling 1 year sell fraction (%) over Quarantine.

Figure 6: Rolling 1Y sharpe ratio



Note: Figure 6 presents top 5 strategies' rolling 1 year Sharpe ratio (unitless) over Quarantine.

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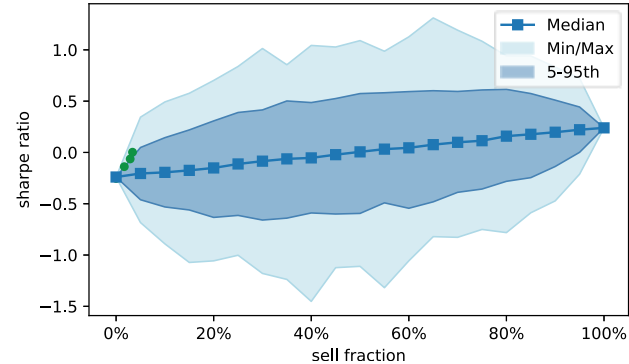
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Machine Learning Report - Appendix: 09/06/2018

10Y Treasuries: Top 5 SVM-RBF-None performance measurement

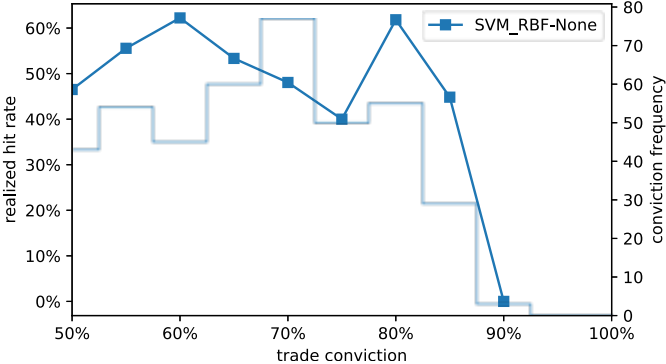
Quarantine Period: 01/03/2017 to 08/28/2018; Cross Validation Period: 01/03/2008 to 12/31/2016

Figure 1: Top 5 strategies Sharpe vs Benchmark



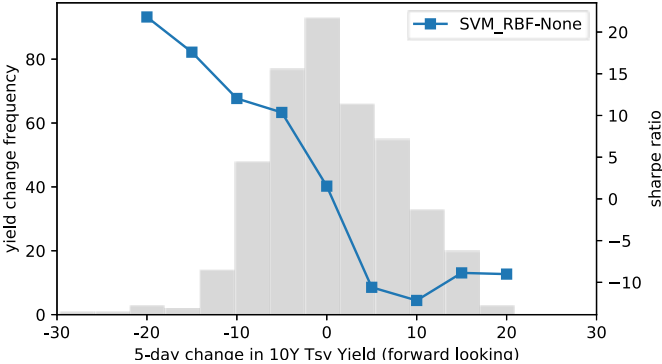
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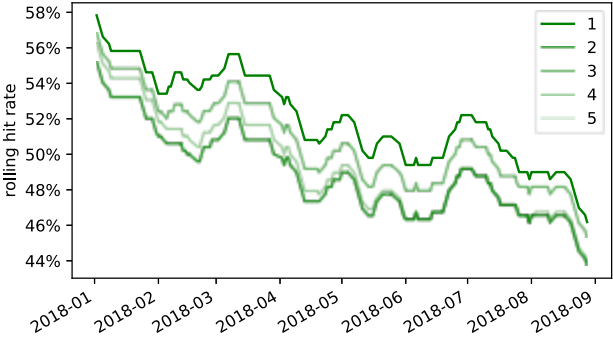
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Figure 3: Top 5 strategies Avg Sharpe by rally/sell-off



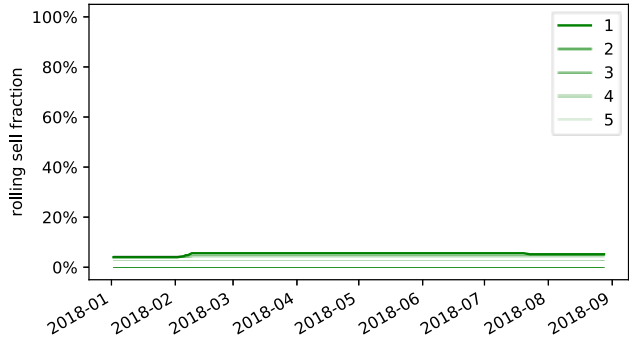
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Figure 4: Rolling 1Y hit rate



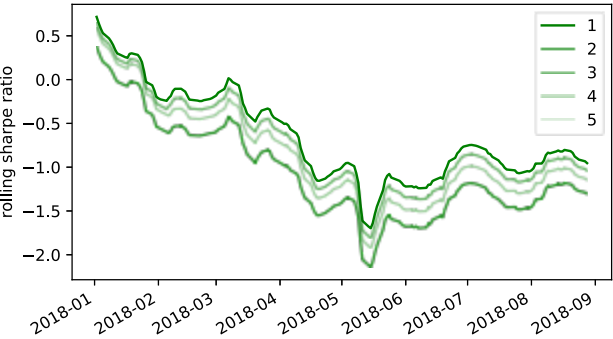
Note: Figure 4 presents top 5 strategies' rolling 1 year hit rate (%) over Quarantine.

Figure 5: Rolling 1Y sell fraction



Note: Figure 5 presents top 5 strategies' rolling 1 year sell fraction (%) over Quarantine.

Figure 6: Rolling 1Y sharpe ratio



Note: Figure 6 presents top 5 strategies' rolling 1 year Sharpe ratio (unitless) over Quarantine.

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