Forex
Hedging With
Machine Learning

Capstone project by Wei Hao

Disclaimer

I'M NOT YOUR FINANCIAL ADVISOR. THIS IS NOT FINANCIAL ADVICE

Do Your Own Due Diligence

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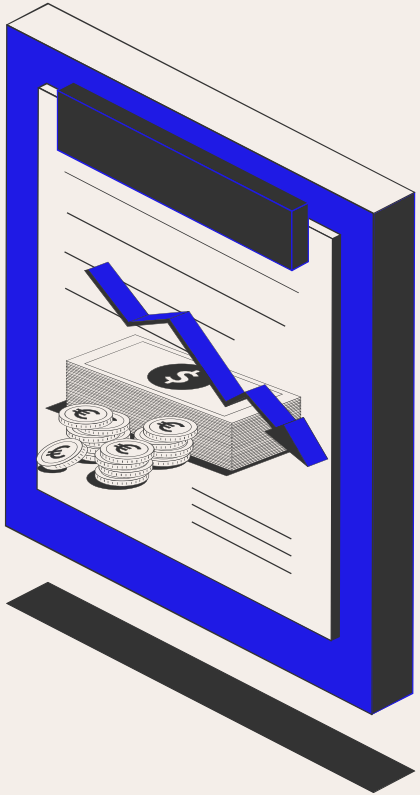
Problem Statement

- Companies that conduct business internationally are exposed to foreign currency risk.
- Possibility that the value of a foreign currency will change in a way that is unfavorable to the company.
- Sales, Investments, Properties



Original position

Goods sold worth USD 100K to Germany

As USD Strengthened against the EUR

Reducing it's value to USD 90k

So you open a hedge

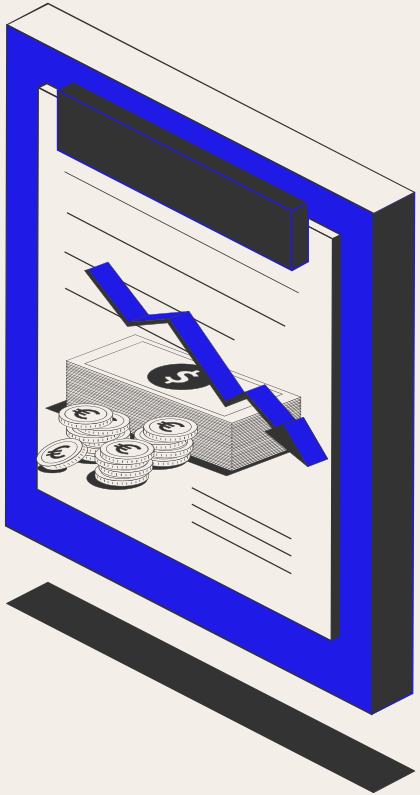
Open a short EUR/USD CFD contract

As EUR Declines against USD

Profit used to offset loss in value of the goods

Problem Statement

- Companies typically use complex financial instruments
  - Forward Contracts
  - Futures Contracts
  - Options
  - CFDs
- Costs:
  - Upfront Premium cost
  - Ongoing cost for maintaining the hedge
  - Opportunity cost of not cashing in on favourable movements

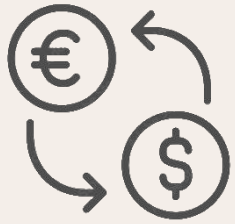


OANDA API

We'll be utilising OANDA's built in API to pull historical Data and also to implement our model into production

- They're simple
- Loads of tutorial online
- Libraries that compliment the API

Dataset



EUR/USD

Period: Sep 20 - Aug 22 (24 mths)
Granularity: 5 mins
Datasets: 148,874


EUR/USD Closing price
close
1.20
1.15
1.10
1.05
1.00
2020-10
2021-01
2021-04
2021-07
2021-10
2022-01
2022-04
2022-07
2022-10
time

Defining Target Variable (Binary)

time	close
2020-09-01 00:00:00	1.19436
2020-09-01 00:05:00	1.19451
2020-09-01 00:10:00	1.19472
2020-09-01 00:15:00	1.19468
2020-09-01 00:20:00	1.19448

We look at only the Close price

time	close	returns
2020-09-01 00:00:00	1.19436	NaN
2020-09-01 00:05:00	1.19451	0.000126
2020-09-01 00:10:00	1.19472	0.000176
2020-09-01 00:15:00	1.19468	-0.000033
2020-09-01 00:20:00	1.19448	-0.000167

creating a column for the log returns between intervals

time	close	returns	dir
2020-09-01 00:05:00	1.19451	0.000126	1
2020-09-01 00:10:00	1.19472	0.000176	1
2020-09-01 00:15:00	1.19468	-0.000033	0
2020-09-01 00:20:00	1.19448	-0.000167	0

The Target variable indicates if the returns is positive or negative

Defining Target Variable (Multiclass)

time	close
2020-09-01 00:00:00	1.19436
2020-09-01 00:05:00	1.19451
2020-09-01 00:10:00	1.19472
2020-09-01 00:15:00	1.19468
2020-09-01 00:20:00	1.19448

We look at only the Close price

time	close	returns
2020-09-01 00:00:00	1.19436	NaN
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2020-09-01 00:15:00	1.19468	-0.000033
2020-09-01 00:20:00	1.19448	-0.000167

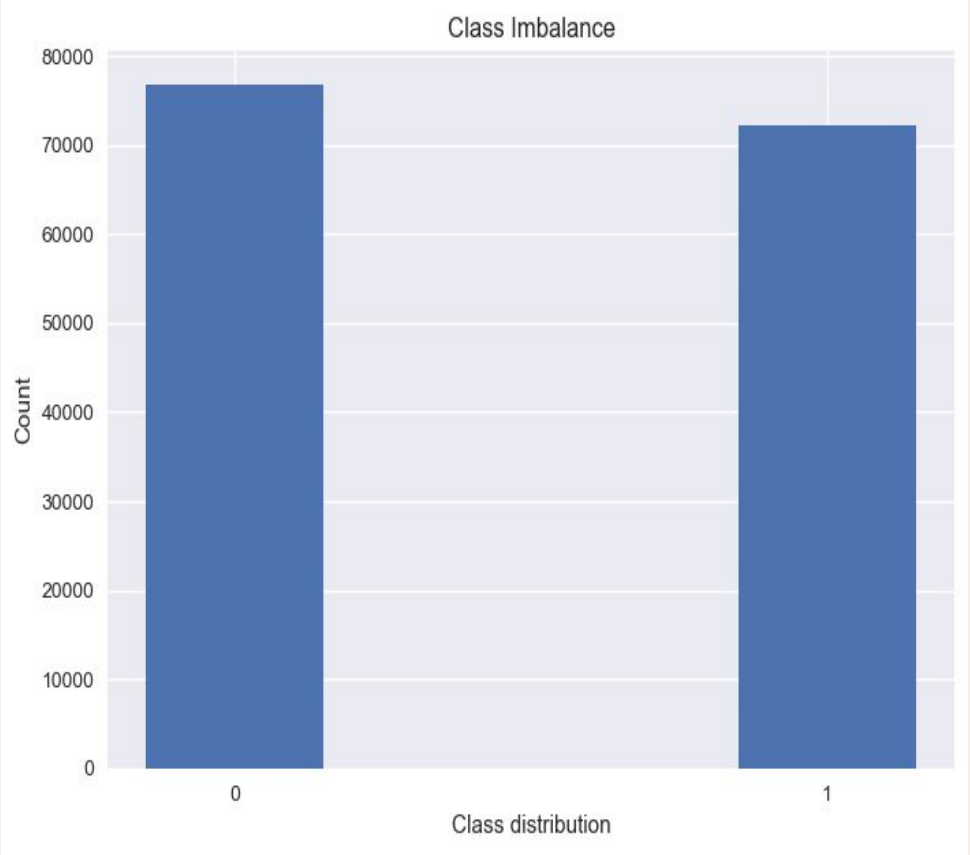
creating a column for the log returns between intervals

vol_lag_4	vol_lag_5	dir_class
0.000408	0.000424	1
0.000407	0.000408	-1
0.000407	0.000407	0
0.000409	0.000407	-1

-1 if Returns > 0.5 b.p. & dir ==-1
0 if returns <= 0.5 b.p.
1 if Returns > 0.5 b.p. & dir ==+1

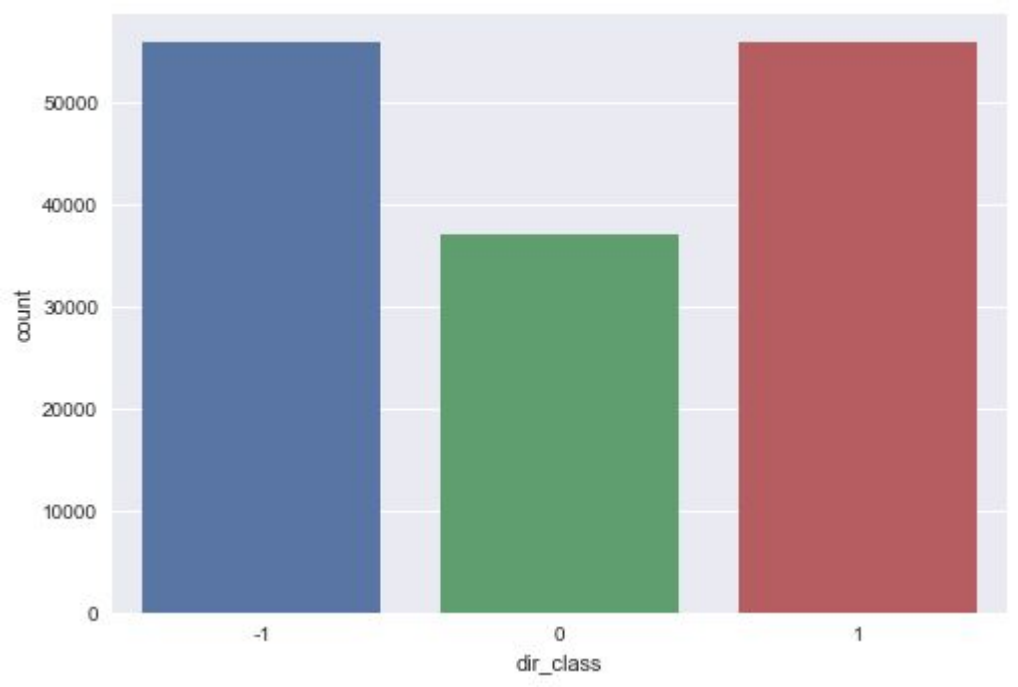
Class imbalance (Binary)

Class	Count	%
0	76718	51.5%
1	72155	48.5%



Class imbalance (Multiclass)

Class	Count	%
-1	55942	37.59%
0	55874	37.54%
1	37004	24.86%



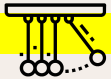
Feature Transformation

Simple Moving average

df['close'].rolling(25).mean() - df['close'].rolling(50).mean()

Bollinger band

df['close'].rolling(25).mean() + df['close'].rolling(25).std()* 2
df['close'].rolling(25).mean() - df['close'].rolling(25).std()* 2



Momentum

df["returns"].rolling(3).mean()

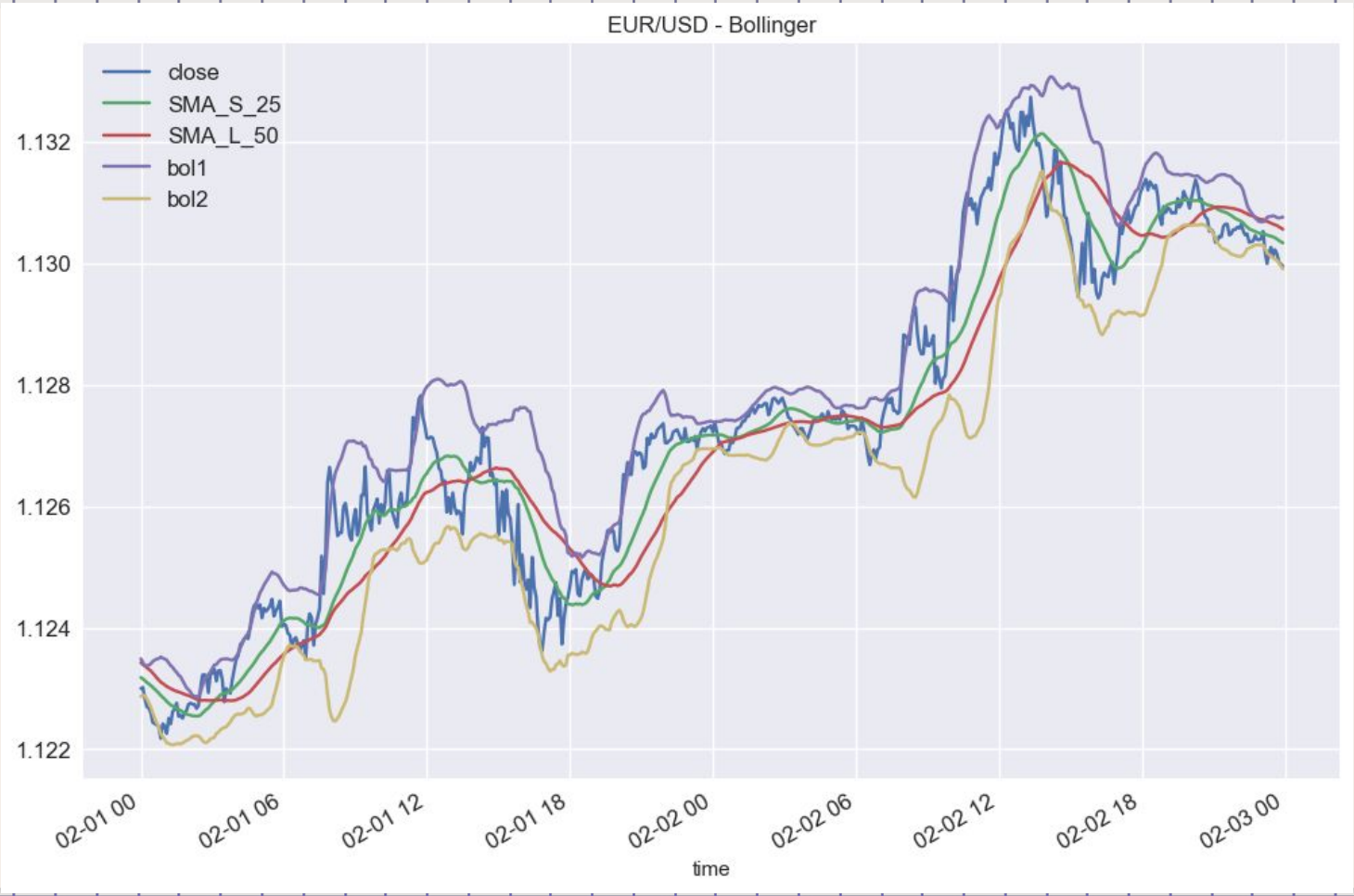
Min/Max

df['close'].rolling(25).min() / df['close'] - 1
df['close'].rolling(25).max() / df['close'] - 1

Volatility

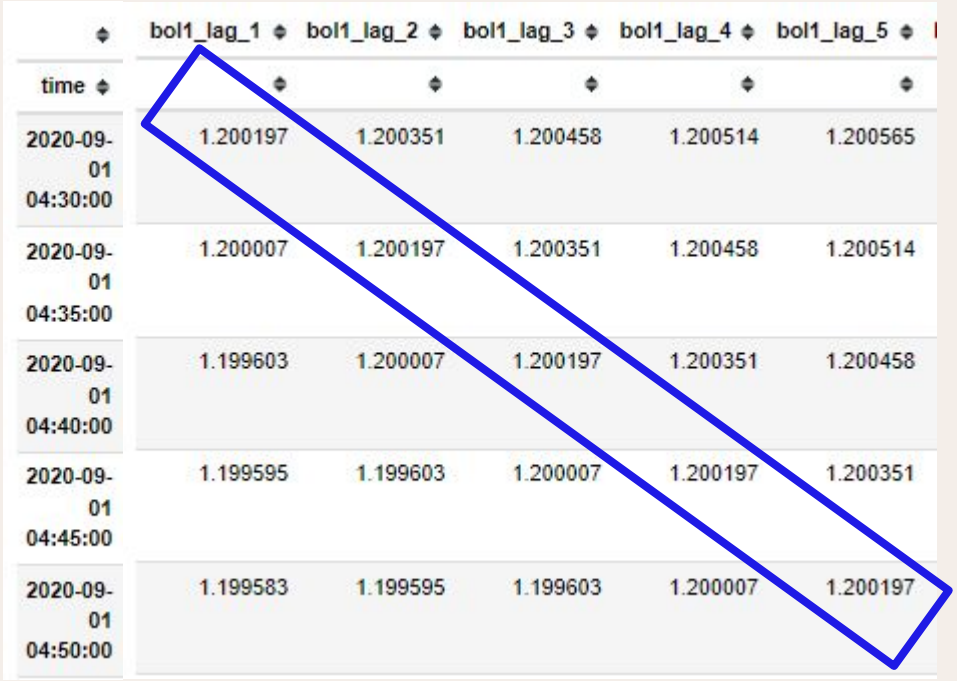
df["returns"].rolling(25).std()


EUR/USD - SMA
close
SMA_S_25
SMA_L_50
1.145
1.140
1.135
1.130
1.125
02-01 00
02-01 12
02-02 00
02-02 12
02-03 00
02-03 12
02-04 00
time


EUR/USD - Bollinger
close
SMA_S_25
SMA_L_50
bol1
bol2
1.132
1.130
1.128
1.126
1.124
1.122
02-01 00
02-01 06
02-01 12
02-01 18
02-02 00
02-02 06
02-02 12
02-02 18
02-03 00
time

Adding Lags

40 Columns

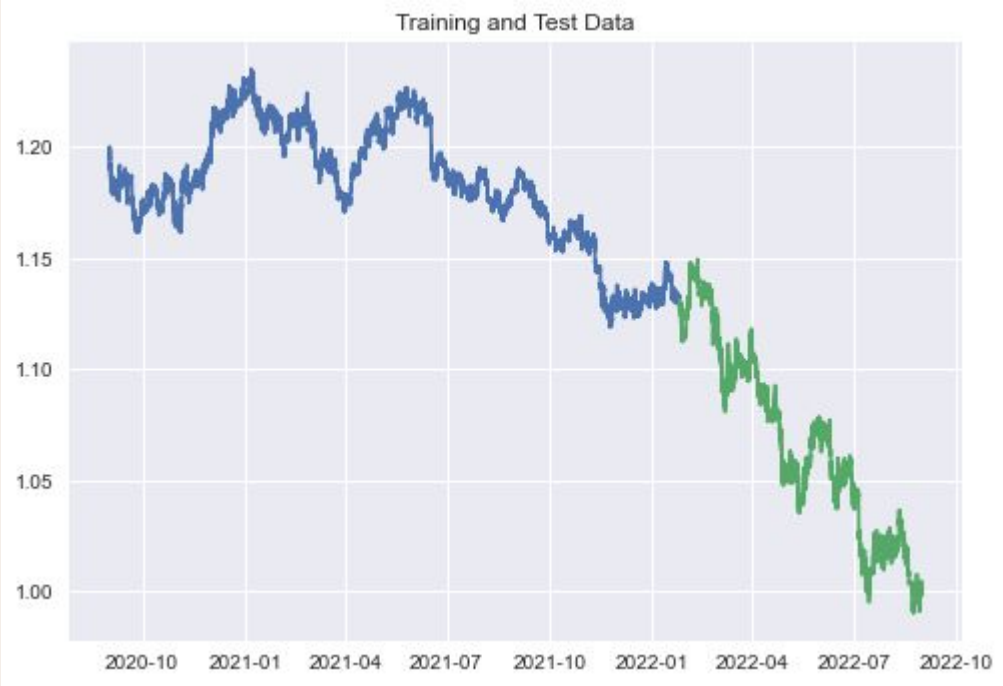


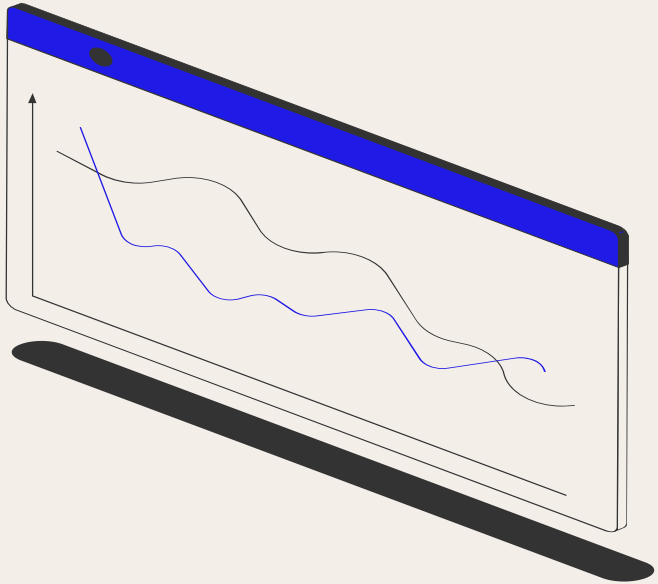
time	bol1_lag_1	bol1_lag_2	bol1_lag_3	bol1_lag_4	bol1_lag_5
2020-09-01 04:30:00	1.200197	1.200351	1.200458	1.200514	1.200565
2020-09-01 04:35:00	1.200007	1.200197	1.200351	1.200458	1.200514
2020-09-01 04:40:00	1.199603	1.200007	1.200197	1.200351	1.200458
2020-09-01 04:45:00	1.199595	1.199603	1.200007	1.200197	1.200351
2020-09-01 04:50:00	1.199583	1.199595	1.199603	1.200007	1.200197

Train Test Split

Train 70%
Test 30%

With standard Scaling





Modeling

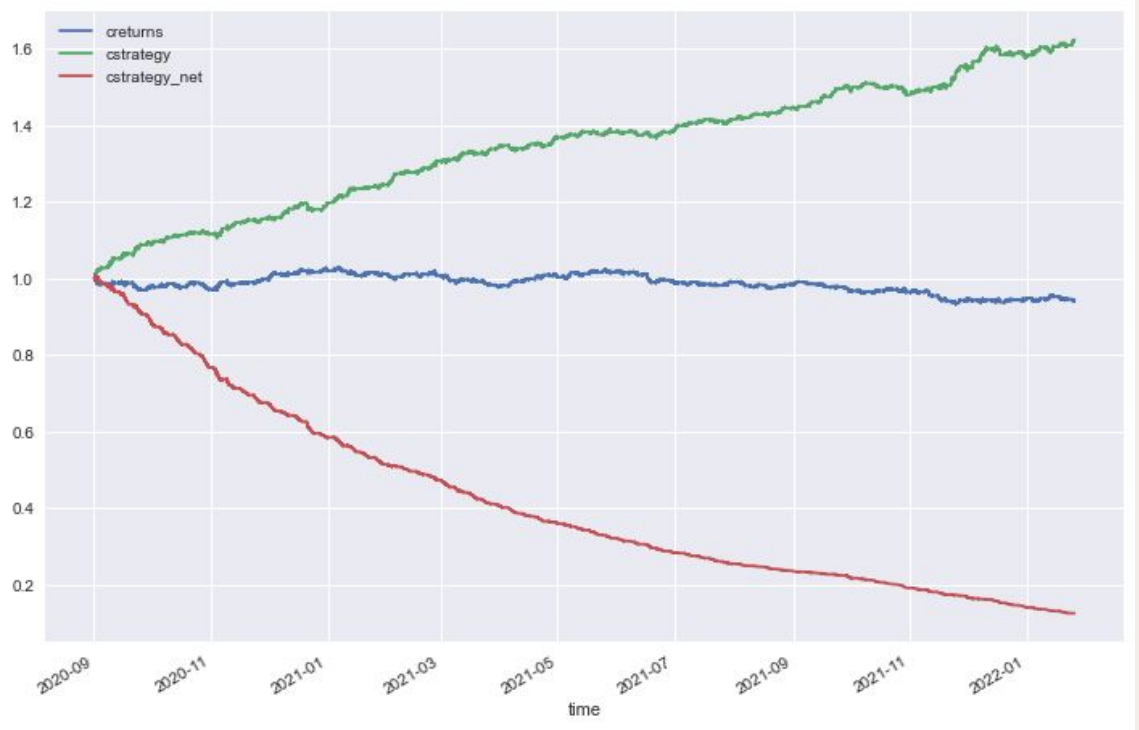
- Log_reg
- XGBoost
- DNN

Models

Model	Classification	Train ACC	Test ACC	%
Log_reg	MultiClass	39.66%	42.37%	-6.83%
XGBoost	Multiclass	62.30%	41.67%	33.11%
DNN	Binary	52.10%	50.54%	2.99%

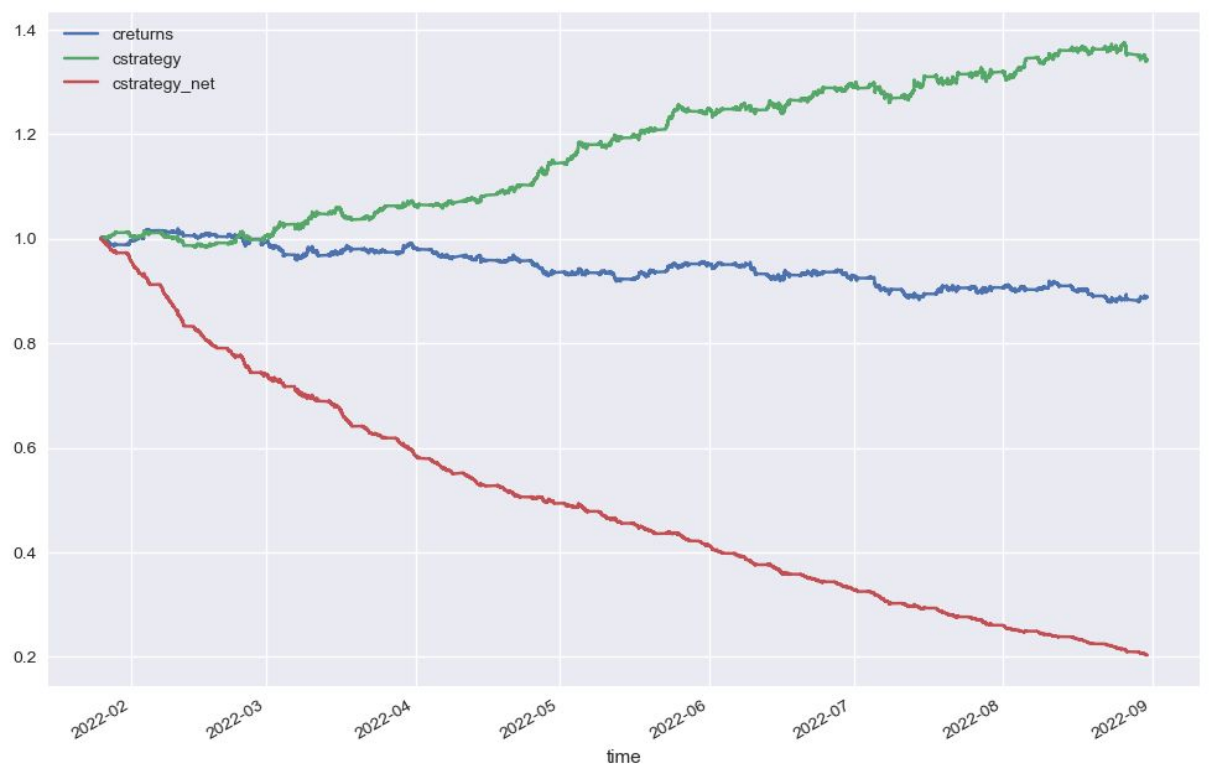
Logistic Regression

In-Sample Backtesting With 1 b.p.

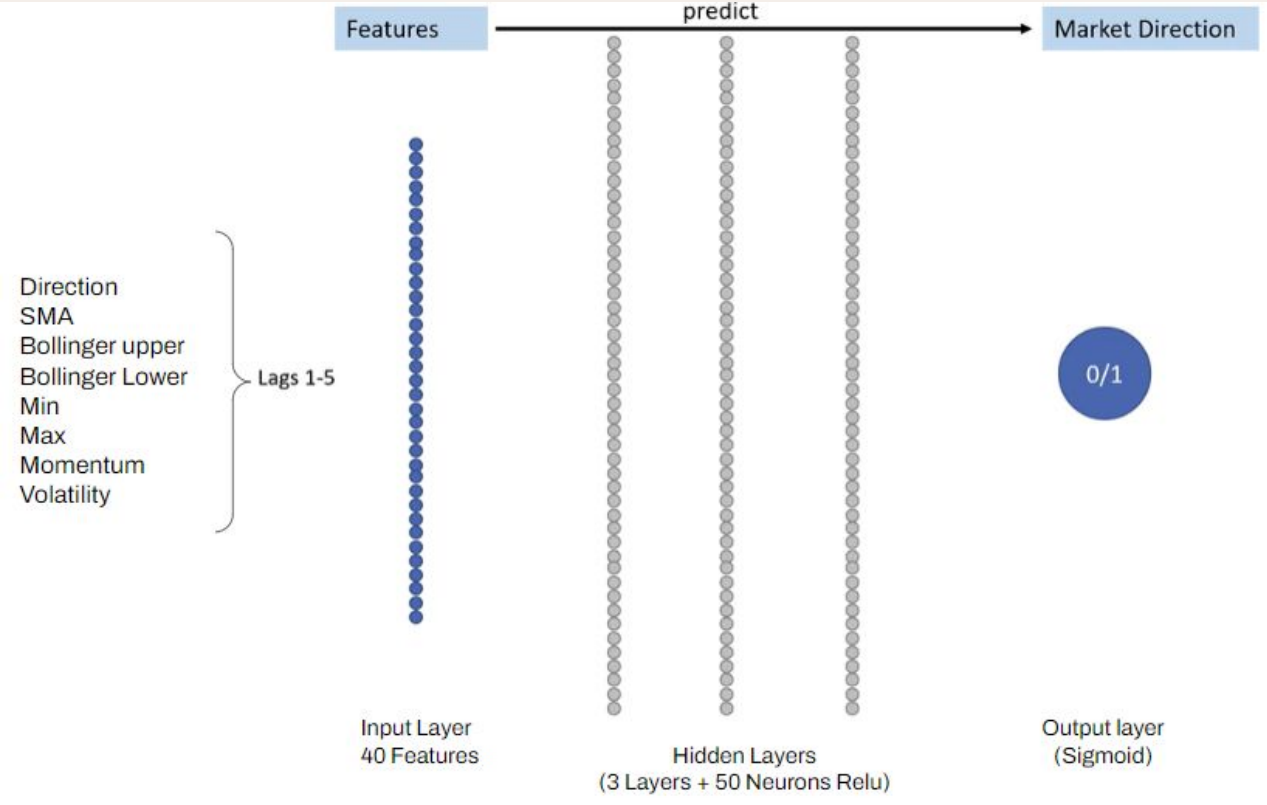


XGBoost

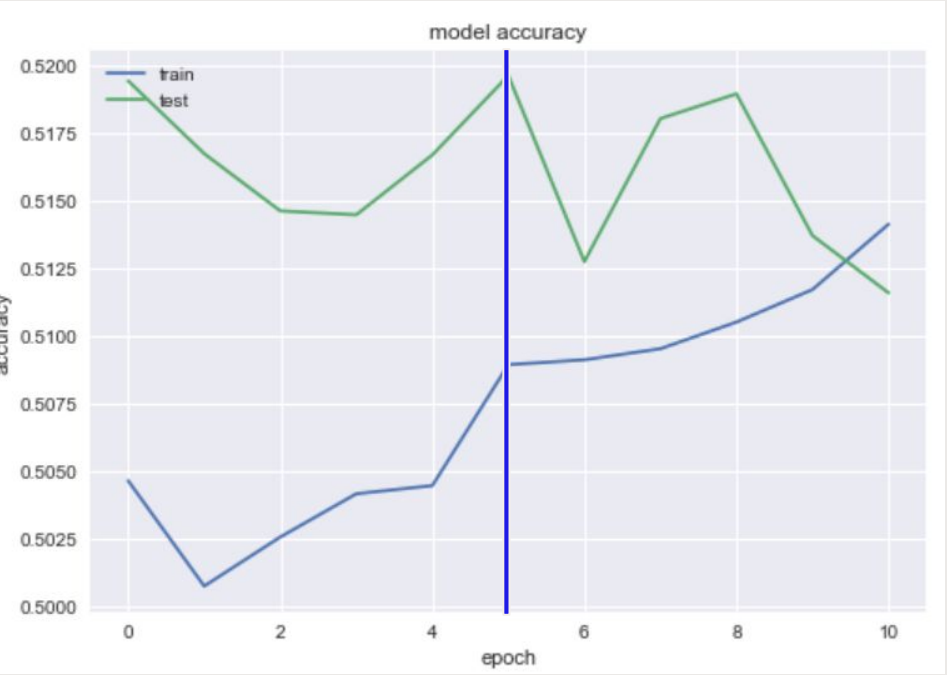
Out-Sample Forward Testing With 1 b.p.

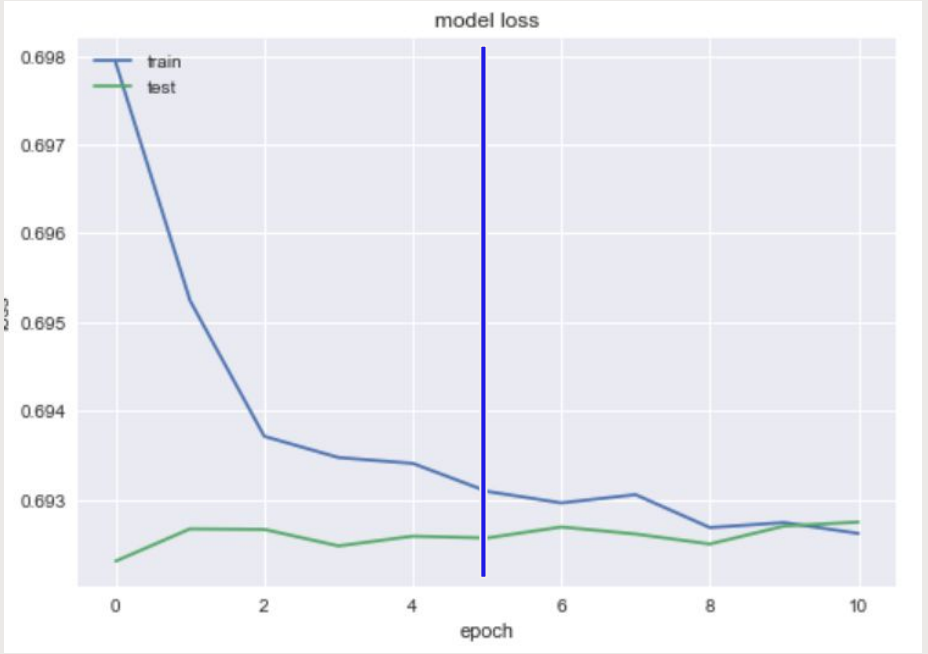


DNN Model


Features
predict
Market Direction
Direction
SMA
Bollinger upper
Bollinger Lower
Min
Max
Momentum
Volatility
Lags 1-5
0/1
Input Layer
40 Features
Hidden Layers
(3 Layers + 50 Neurons Relu)
Output layer
(Sigmoid)

DNN Model


model accuracy
train
test
0.5200
0.5175
0.5150
0.5125
0.5100
0.5075
0.5050
0.5025
0.5000
0
2
4
6
8
10
epoch


model loss
train
test
0.698
0.697
0.696
0.695
0.694
0.693
0
2
4
6
8
10
epoch

DNN Model

In-sample Testing

For the DNN model
Used prediction probability to
Determine Buy, Sell or Hold

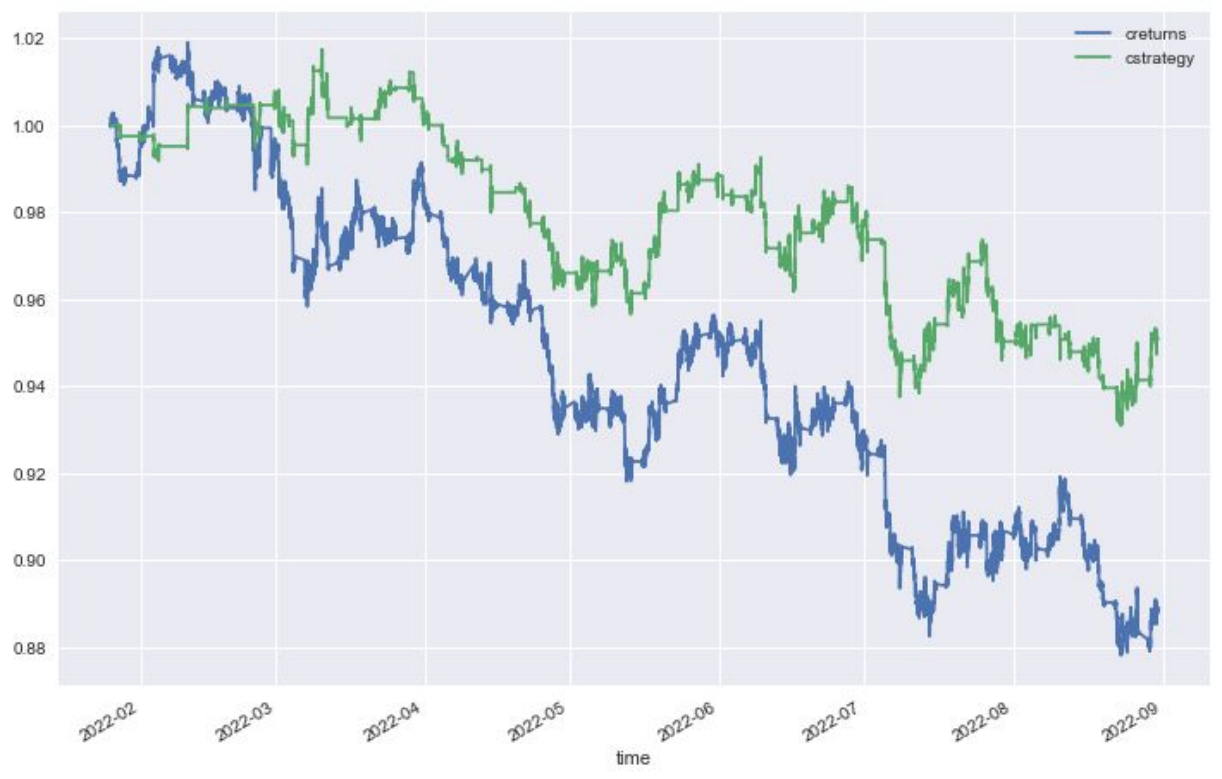
- Probability >=53 -> Buy
- Probability <= 47 -> Sell
- Probability between 47 & 53 -> Hold

^ ^

(Exclusive)

DNN Model

Out-Sample
Forward Testing

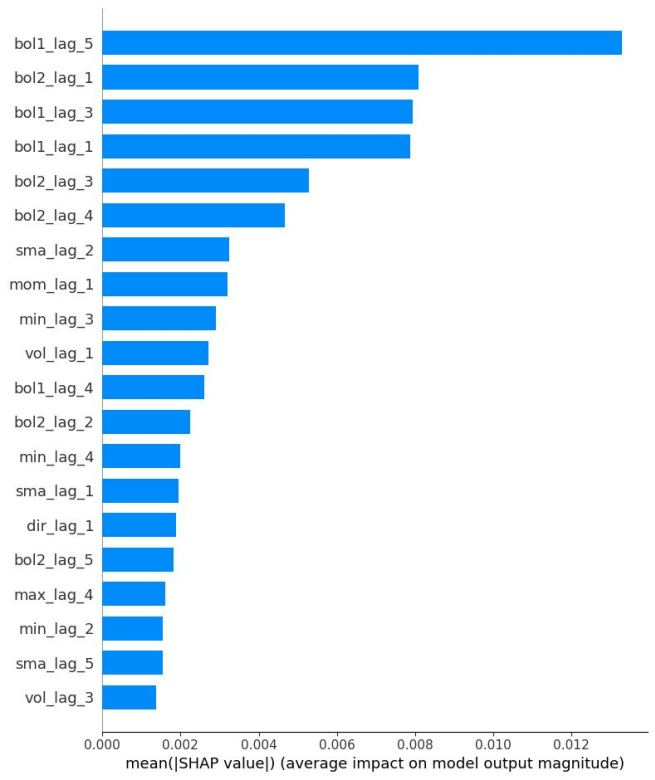


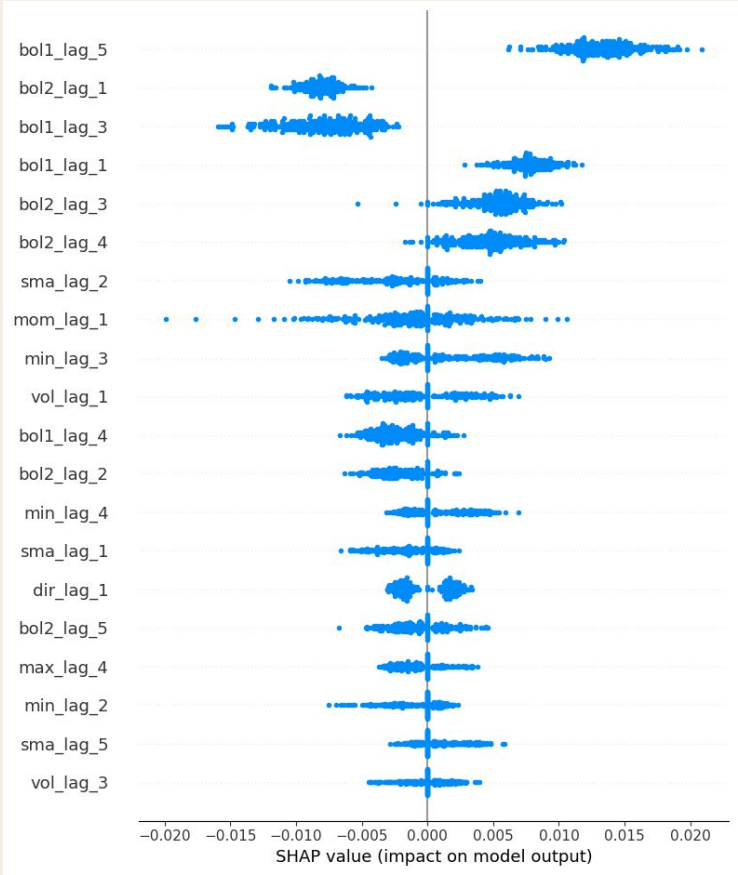
DNN Model

Out-Sample Forward Testing
With 1 b.p. spread

Strategy = 0.950971
Net strategy = 0.936157
Buy & hold = 0.888743
% diff = 5.065%

SHAP


bol1_lag_5
bol2_lag_1
bol1_lag_3
bol1_lag_1
bol2_lag_3
bol2_lag_4
sma_lag_2
mom_lag_1
min_lag_3
vol_lag_1
bol1_lag_4
bol2_lag_2
min_lag_4
sma_lag_1
dir_lag_1
bol2_lag_5
max_lag_4
min_lag_2
sma_lag_5
vol_lag_3
0.000
0.002
0.004
0.006
0.008
0.010
0.012
mean(|SHAP value|) (average impact on model output magnitude)


bol1_lag_5
bol2_lag_1
bol1_lag_3
bol1_lag_1
bol2_lag_3
bol2_lag_4
sma_lag_2
mom_lag_1
min_lag_3
vol_lag_1
bol1_lag_4
bol2_lag_2
min_lag_4
sma_lag_1
dir_lag_1
bol2_lag_5
max_lag_4
min_lag_2
sma_lag_5
vol_lag_3
−0.020
−0.015
−0.010
−0.005
0.000
0.005
0.010
0.015
0.020
SHAP value (impact on model output)

Implementation

Implementing DNN model to OANDA

DNN Model Implementation

```
622 623 624 625 626 627 628 629 630 631 632 633 634 635 636 637 638 639 640 641 642 643 644 645 646 647 648 649 650 651 652 653
654 655 656 657 658 659 660 661 662 663 664 665 666 667 668 669 670 671 672 673 674 675 676 677 678 679 680 681 682 683 684 685
686 687 688 689 690 691 692 693 694 695 696 697 698 699 700 701 702 703 704 705 706 707 708 709 710 711 712 713 714 715 716 717
718 719 720 721 722 723 724 725 726 727 728 729 730 731 732 733 734 735 736 737 738 739 740 741 742 743 744 745 746 747 748 749
750 751 75

--------------------------------------------------------------------------------
2022-10-19T18:50:01.020118227Z | GOING LONG
2022-10-19T18:50:01.020118227Z | units = 100000.0 | price = 0.97679 | P&L = 0.0 | Cum P&L = 0.0
--------------------------------------------------------------------------------

23/23 [==============================] - 0s 1ms/step766 767 768 769 770 771 772 773 774 775 776 777 778 779 780 781 782 783 784
785 786 787 788 789 790 791 792 793 794 795 796 797 798 799 800 801 802 803 804 805 806 807 808 809 810 811 812 813 814 815 816
817 818 819 820 821 822 823 824 825 826 827 828 829 830 831 832 833 834 835 836 837 838 839 840 841 842 843 844 845 846 847 848
849 850 851 852 853 854 855 856 857 858 859 860 861 862 863 864 865 866 867 868 869 870 871 872 873 874 875 876 877 878 879 880
881 882 883 884 885 886 887 888 889 890 891 892 893 894 895 896 897 898 899 900 901 902 903 904 905 906 907 908 909 910 911 912
91
```


Sell Market EUR/USD
100,000 Units @ 0.97690
10/20/2022, 3:55:00 AM
Spread Cost -4.5000
Commission 0.00
Balance of 100040.00
Ticket Number: 17
EUR/USD, 5, OANDA
O0.97900 H0.97905 L0.97892 C0.97894 −0.00006 (−0.
Buy Market EUR/USD
100,000 Units @ 0.97679
10/20/2022, 2:50:01 AM
Spread Cost -4.0000
Commission 0.00
Balance of 100029.00
Ticket Number: 15
11.00
19:00
19:15
19:30
19:45
20:00
20:15
20:30

API test in 3 days

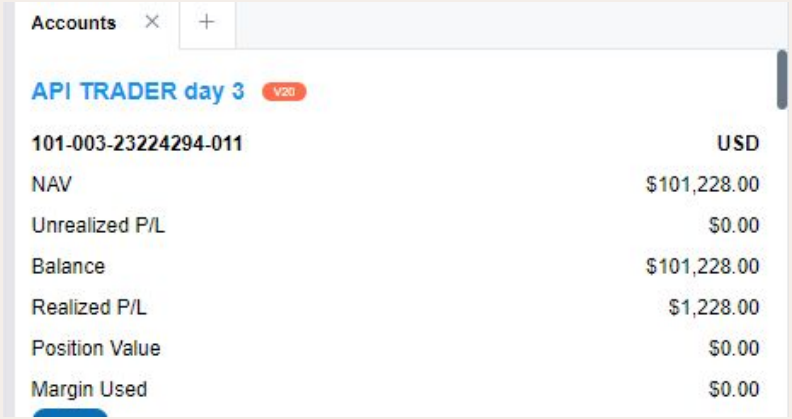
$157	$40	$1228
Day 1	Day 2	Day 3

Based on 100k USD per trade

```
-------------------------------------------------------------------------------------------------------
2022-10-21T12:15:02.290788696Z | GOING LONG
2022-10-21T12:15:02.290788696Z | units = 100000.0 | price = 0.97291 | P&L = 0.0 | Cum P&L = 0.0
-------------------------------------------------------------------------------------------------------

-------------------------------------------------------------------------------------------------------
2022-10-21T13:10:02.409390204Z | GOING SHORT
2022-10-21T13:10:02.409390204Z | units = -200000.0 | price = 0.97833 | P&L = 542.0 | Cum P&L = 542.0
-------------------------------------------------------------------------------------------------------

-------------------------------------------------------------------------------------------------------
2022-10-21T13:20:02.789704936Z | GOING LONG
2022-10-21T13:20:02.789704936Z | units = 200000.0 | price = 0.976 | P&L = 233.0 | Cum P&L = 775.0
-------------------------------------------------------------------------------------------------------
```



Based on 100k USD per trade

Model Performance

Conclusions

Ease of use

Implementation is easy and needs minimal human intervention

Performance

The model performs better as compared to buying and holding on to EUR.

Cash in on Favourable movmt.

The model allows users to take advantage of favourable price movements

Improvements

Data Drift

Model Will need to be retrained frequently.

More Technical indicators

We can experiment with more features to optimise the model for more profits.

particle swarm optimization

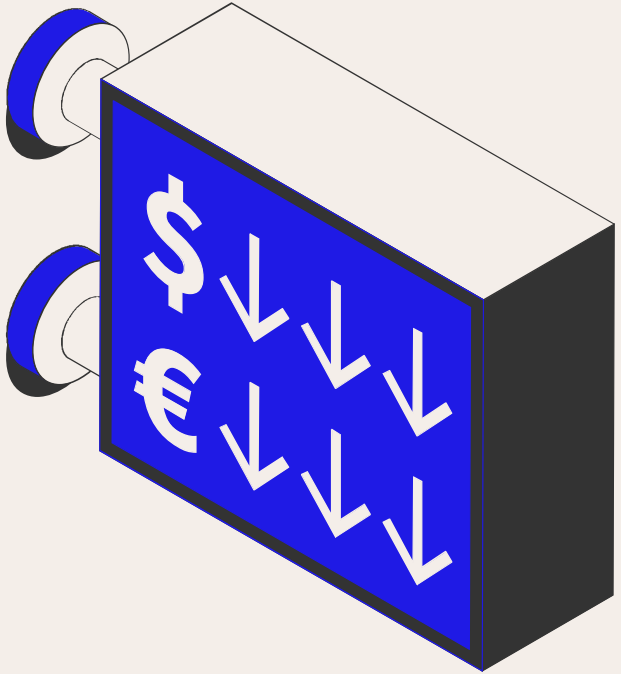
We can try to utilise the PSO activator to see if the model performs better.

Take Profit + Stop Loss

Add in a take profit/ stop loss via the OANDA API.

Thanks!

Do you have any questions?



Credits to Slidesgo for the template

Thanks!

Do you have any questions?

youremail@freepik.com
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