

Hurst Exponent (Simple)

Main idea

$Var(q) = E[|x_{time+q} - x_{time}|^2]$ For every time in sample

$Var(q) \sim q^{2H}$ where H - hurst exponent

```
#%%
def get_hurst_exponent(time_series, max_lag=100):

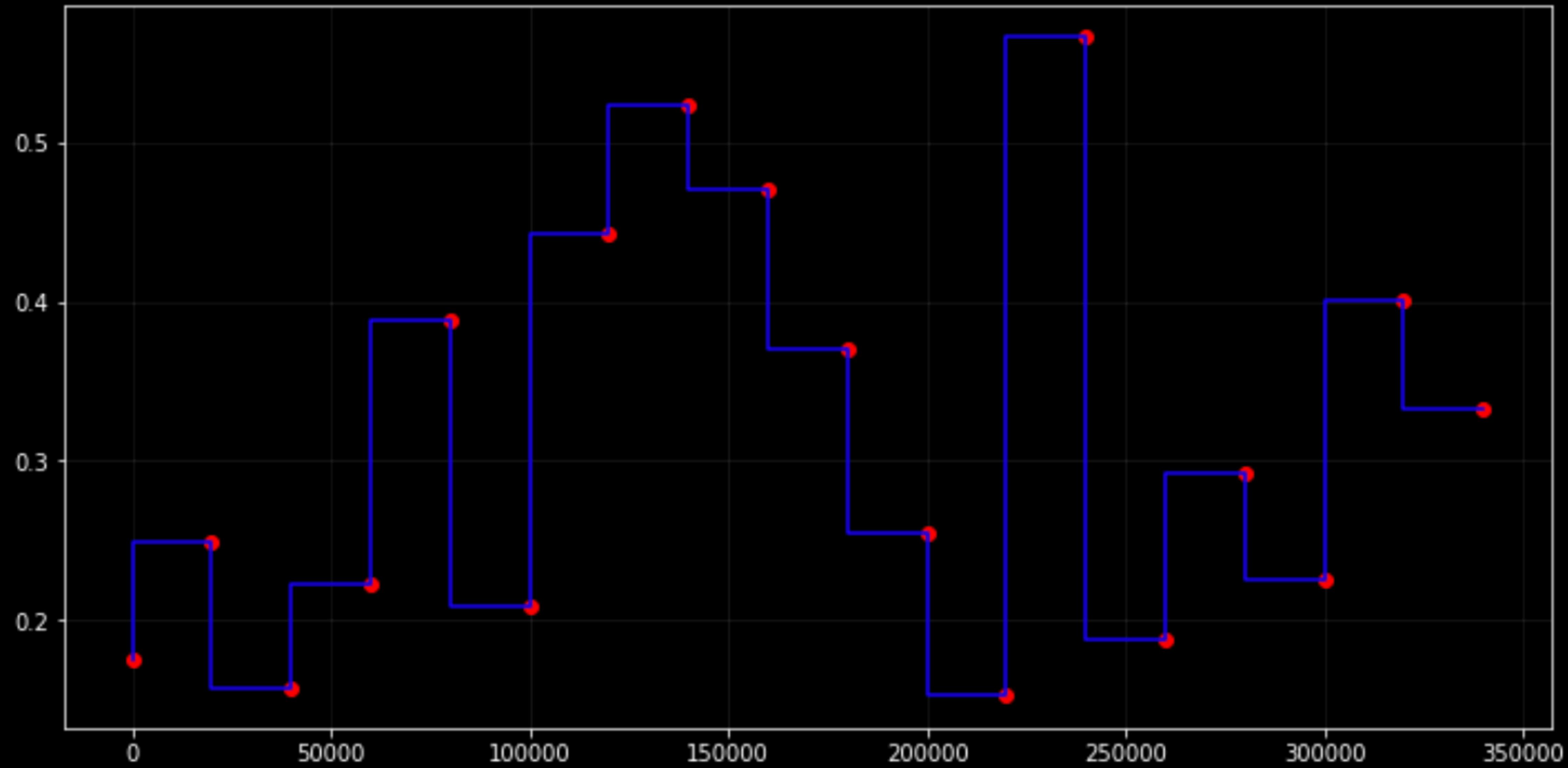
    lags = range(2, max_lag)

    # For every X we calculate X minus X_SHIFTED_Q. Then we calculate STD.
    tau = [np.std(np.subtract(time_series[lag:], time_series[:-lag])) for lag in lags]

    # Log()
    reg = np.polyfit(np.log(lags), np.log(tau), 1)

return reg[0]
```

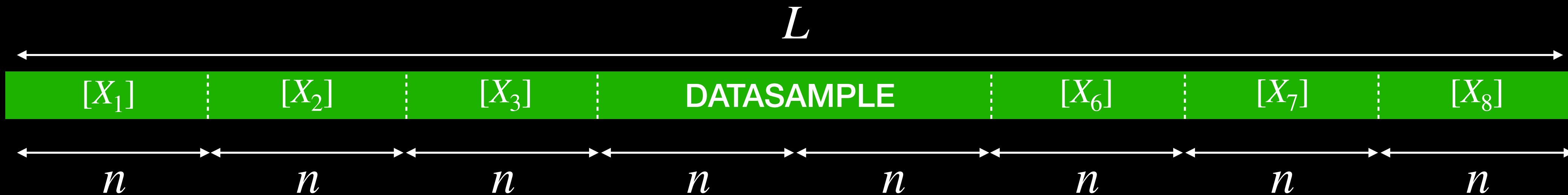
Simple Hurst



Hurst Exponent

Main idea

n = time lag
 L = len(sample)



$$E_m = E[X_m]$$

$$S_m = D[X_m]$$

$$X_m = \text{np.subtract}(X_m - E_m)$$

$$Y_m = \text{np.cumsum}(X_m)$$

1

Range defined as:
 $\max(Y_m) - \min(Y_m)$

2

For each sub series we calculate R_m/S_m

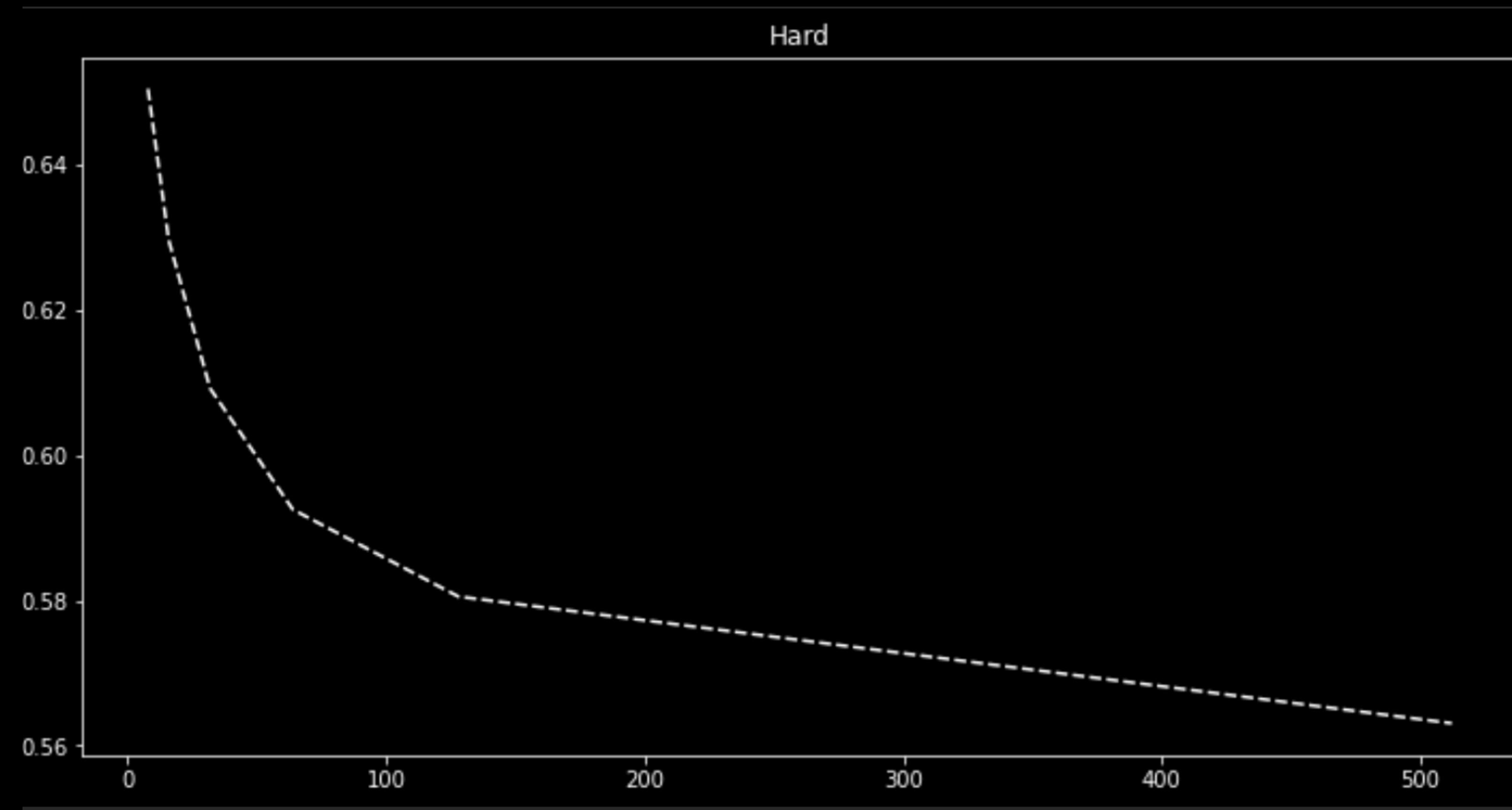
3

By taking mean value from all collected R_m/S_m we get $(R/S)_n$

Repeat steps 1-3 for n in range(2, checking_timelag)

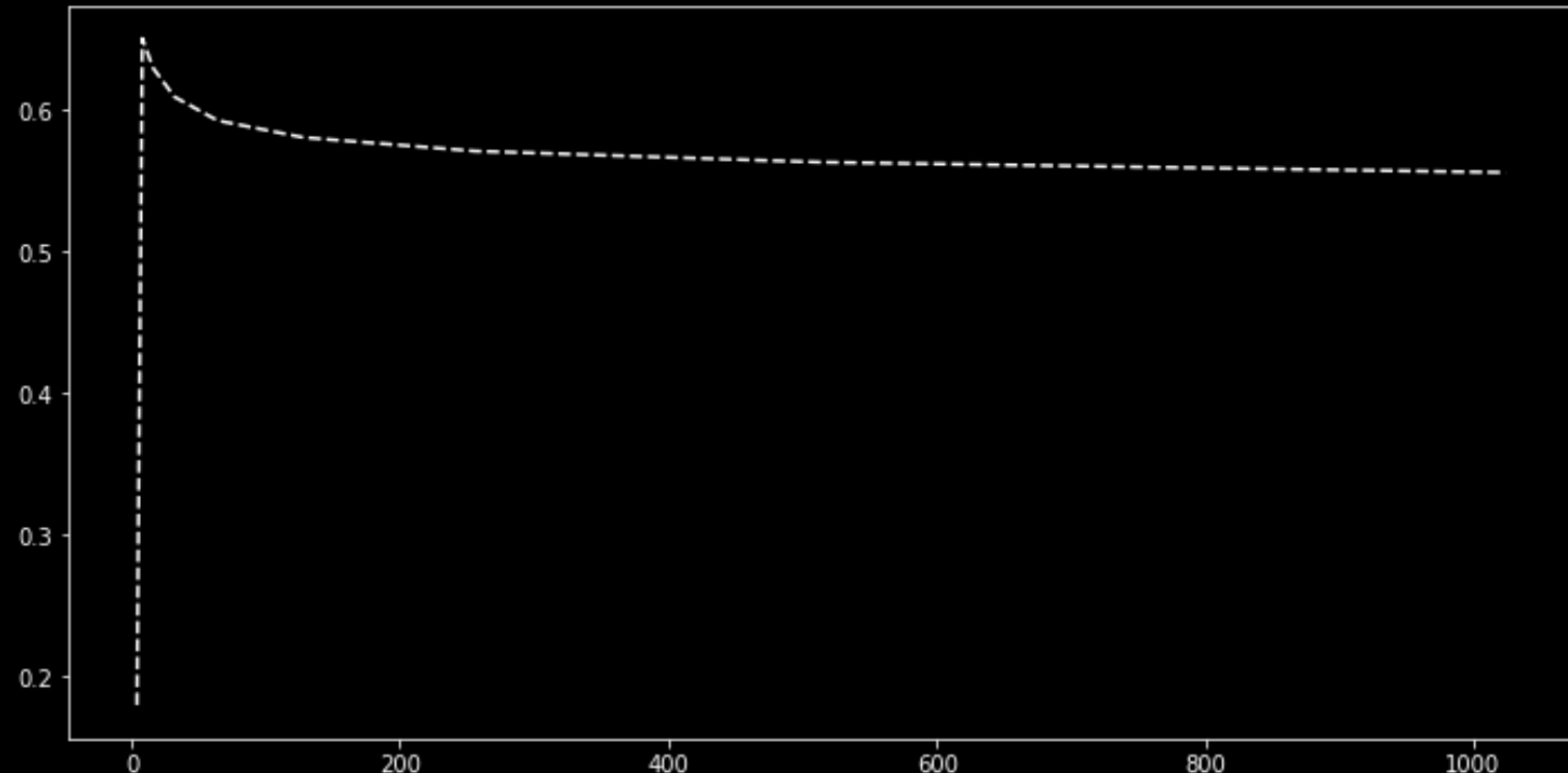
$$(R/S)_n \approx cn^H \quad \longrightarrow \quad \log(R/S)_n = \log \text{Constant} + H \log n$$

$H(\text{time_lag})$



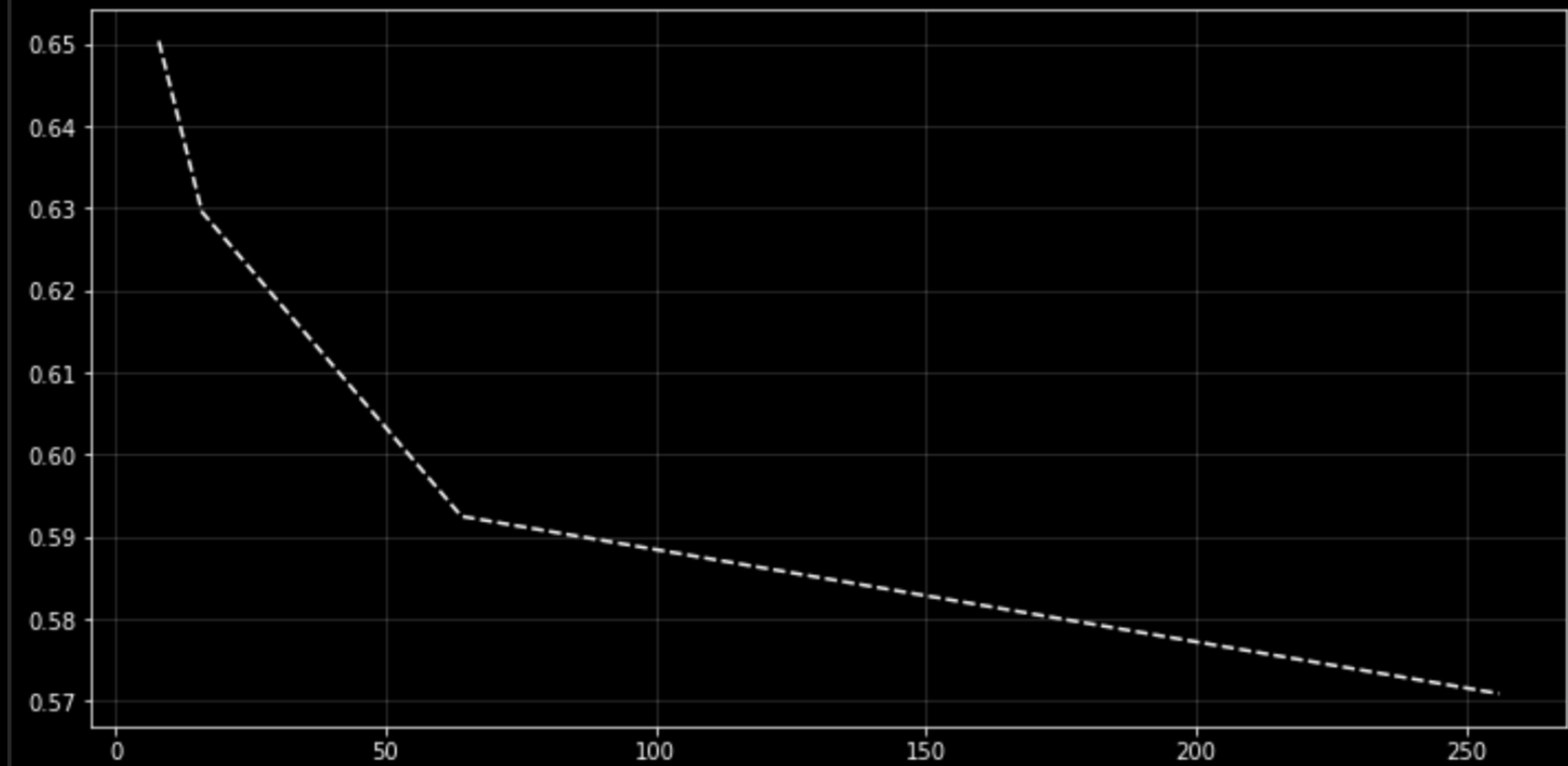
$H(\text{time_lag})$

Hard



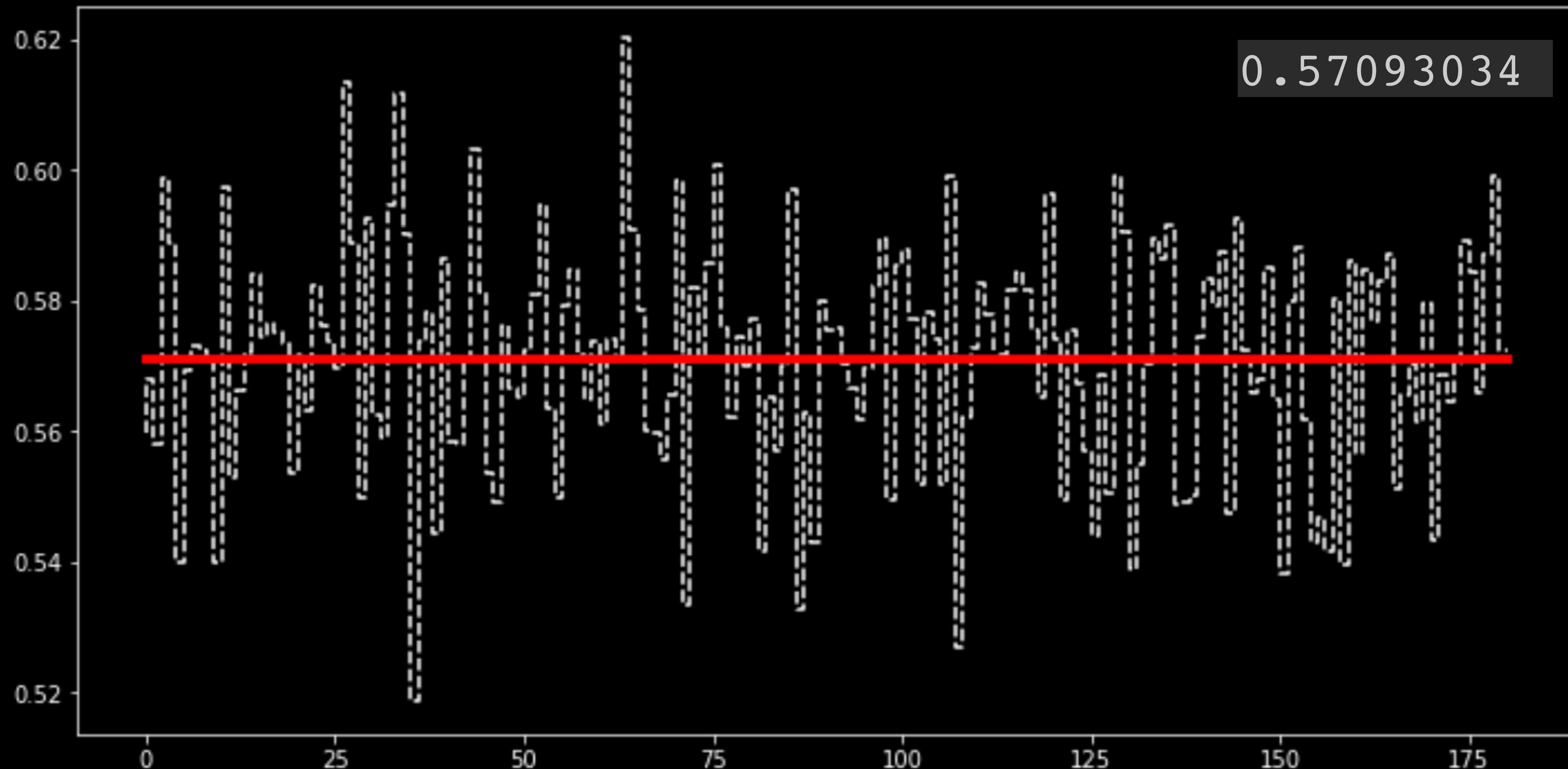
$H(\text{time_lag})$

Hard

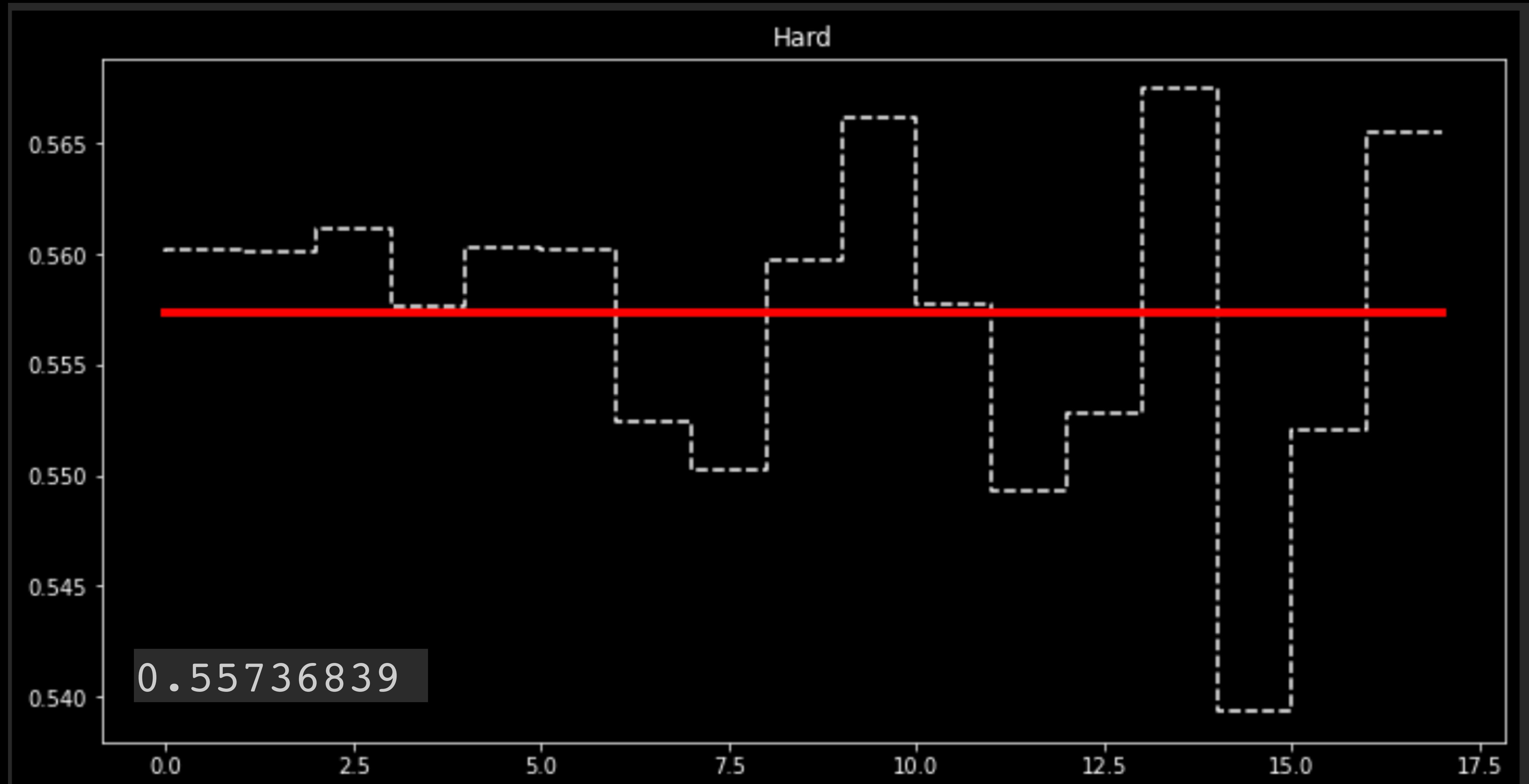


$H(\text{time})$ | Frame = 2000 dotes

Hard



$H(\text{time}) | \text{Frame} = 20000 \text{ dotes}$



Anis And Lloyd formula

$$E(R/S)_n = \begin{cases} \frac{n - \frac{1}{2}}{n} \frac{\Gamma\left(\frac{n-1}{2}\right)}{\sqrt{\pi} \Gamma\left(\frac{n}{2}\right)} \sum_{i=1}^{n-1} \sqrt{\frac{n-i}{i}} & \text{for } n \leq 340 \\ \frac{n - \frac{1}{2}}{n} \frac{1}{\sqrt{n^{\frac{\pi}{2}}}} \sum_{i=1}^{n-1} \sqrt{\frac{n-i}{i}} & \text{for } n \geq 340. \end{cases}$$

$$\log H_n = \log (R/S)_n - \log E (R/S)_n + \log(n)/2$$

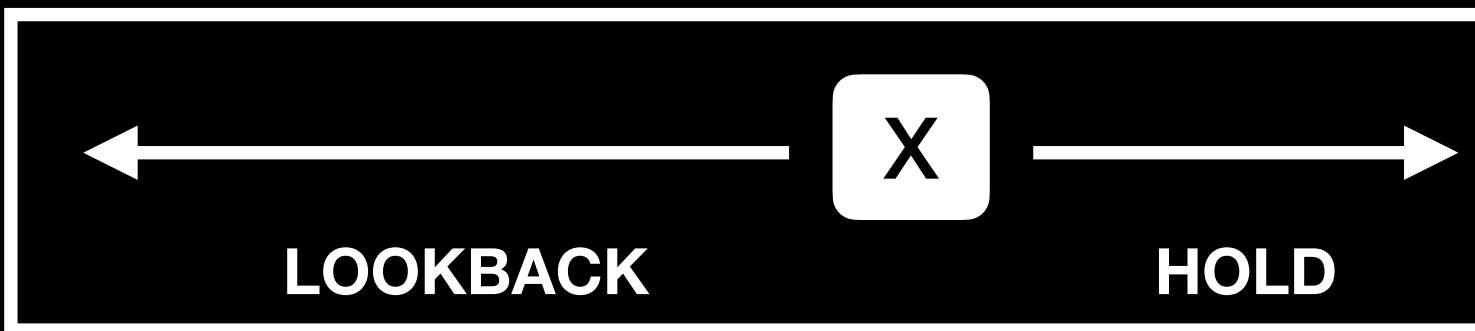
Right now doesn't work correctly

Correlation Table

Main idea

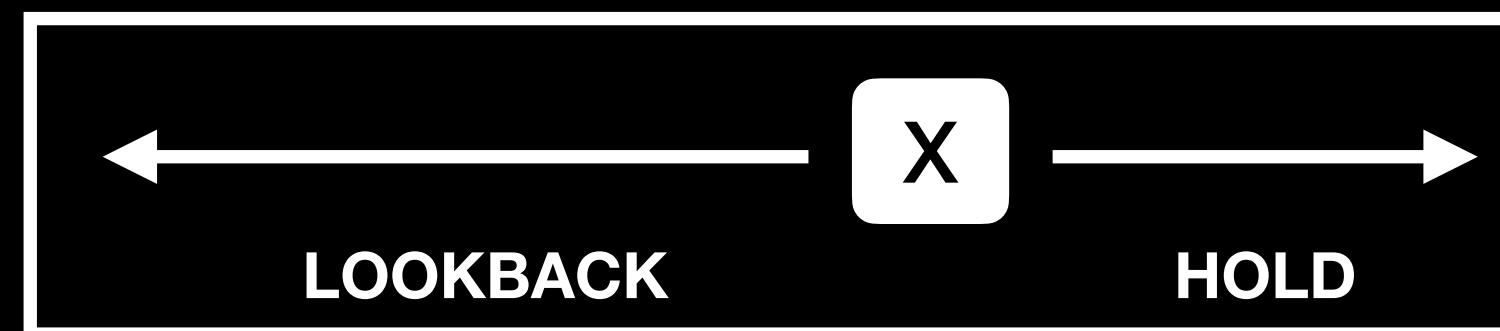
$$r = \frac{\sum_{i=1}^n (x_i - \bar{x})(y_i - \bar{y})}{\sqrt{\sum_{i=1}^n (x_i - \bar{x})^2} \sum_{i=1}^n (y_i - \bar{y})}$$

DATASAMPLE



L1: SUM [RETURNS ON LOOKBACK]

H1: SUM [RETURNS ON HOLD]



L2: SUM [RETURNS ON LOOKBACK]

H2: SUM [RETURNS ON HOLD]



L3: SUM [RETURNS ON LOOKBACK]

H3: SUM [RETURNS ON HOLD]

выборки:

$(X_{1i}, X_{2i}), i = 1, \dots, n,$

нулевая гипотеза:

$H_0: r_{X_1 X_2} = 0;$

альтернатива:

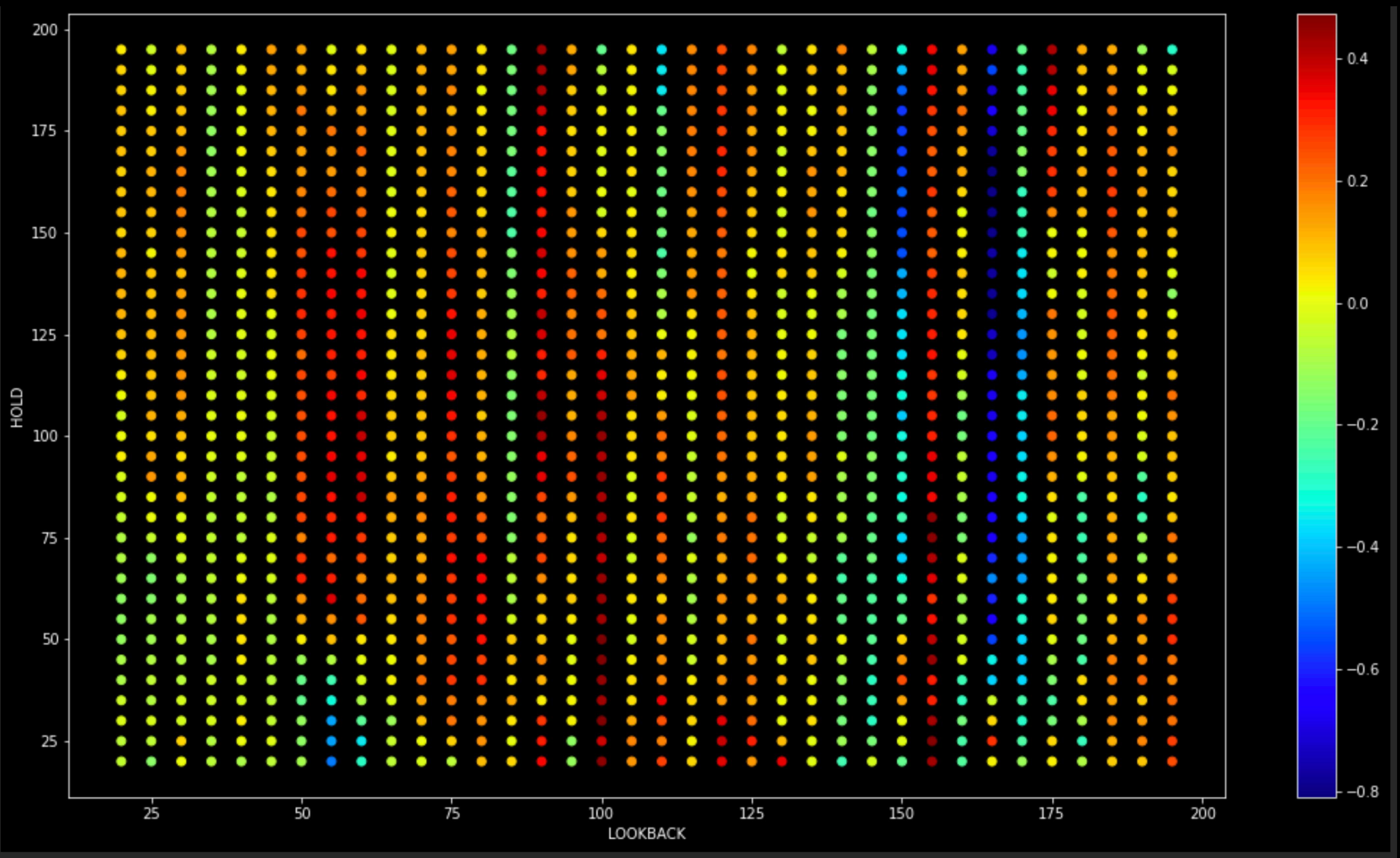
$H_1: r_{X_1 X_2} < \neq > 0;$

статистика:

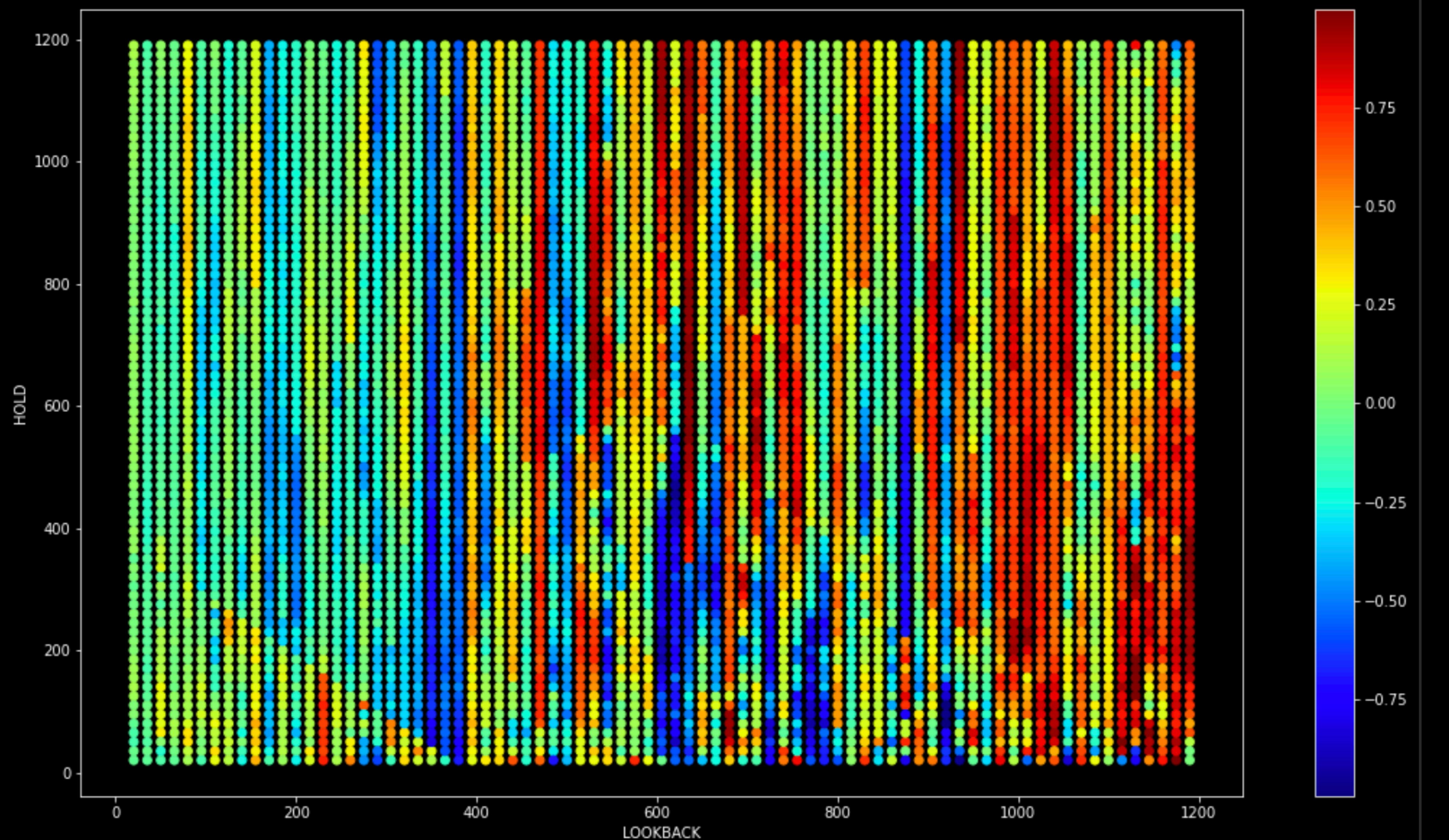
$T = \frac{r_{X_1 X_2} \sqrt{n-2}}{\sqrt{1-r_{X_1 X_2}^2}};$

нулевое распределение:

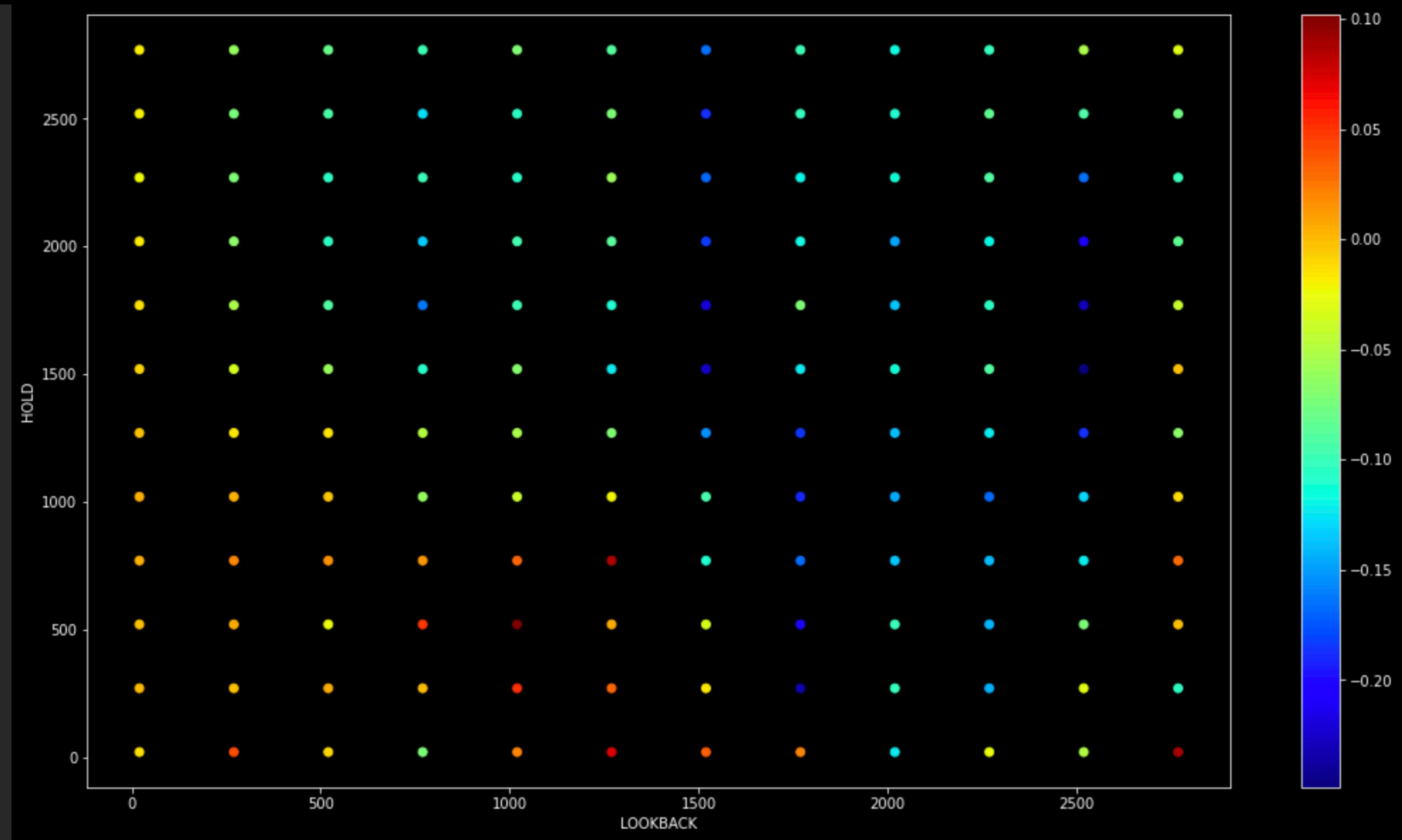
$T \sim St(n-2).$



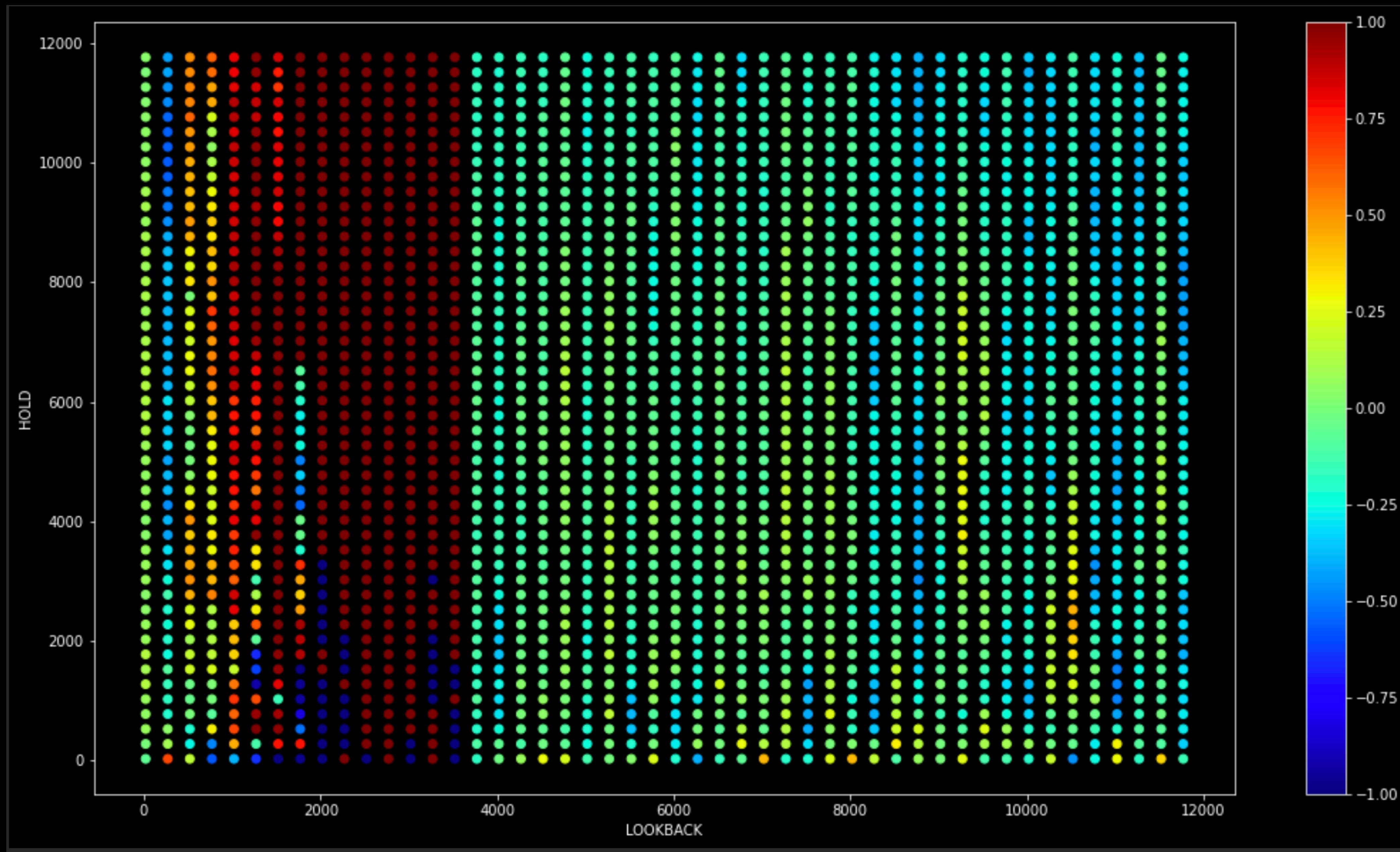
	Pair	LOOKBACK	HOLD	Correlation	P_VALUE
582	L-100;H-50	100	50	0.472874	0.003121
581	L-100;H-45	100	45	0.467447	0.003533
578	L-100;H-30	100	30	0.463258	0.003883
973	L-155;H-25	155	25	0.460199	0.023647
983	L-155;H-75	155	75	0.458936	0.024083
...
1066	L-165;H-130	165	130	-0.788981	0.000013
1070	L-165;H-150	165	150	-0.791409	0.000012
1072	L-165;H-160	165	160	-0.795266	0.000010
1071	L-165;H-155	165	155	-0.802228	0.000007
1073	L-165;H-165	165	165	-0.809704	0.000005



Высокая точность



Пример низкой точности (Четкая линия вызвана Simplify)



VR Ratio

$$VR(q_f) = \frac{\sigma_a^2}{\sigma_b^2}$$

$$\sigma_a^2 = \frac{1}{N} \sum_{k=1}^N [X_k - X_{k-1} - \hat{\mu}]^2$$

$$\sigma_b^2 = \frac{1}{N-q} \sum_{k=q}^N [X_k - X_{k-q} - q\hat{\mu}]^2$$

$$\hat{\mu} = \frac{1}{N} \sum_{k=1}^N [X_k - X_{k-1}]$$

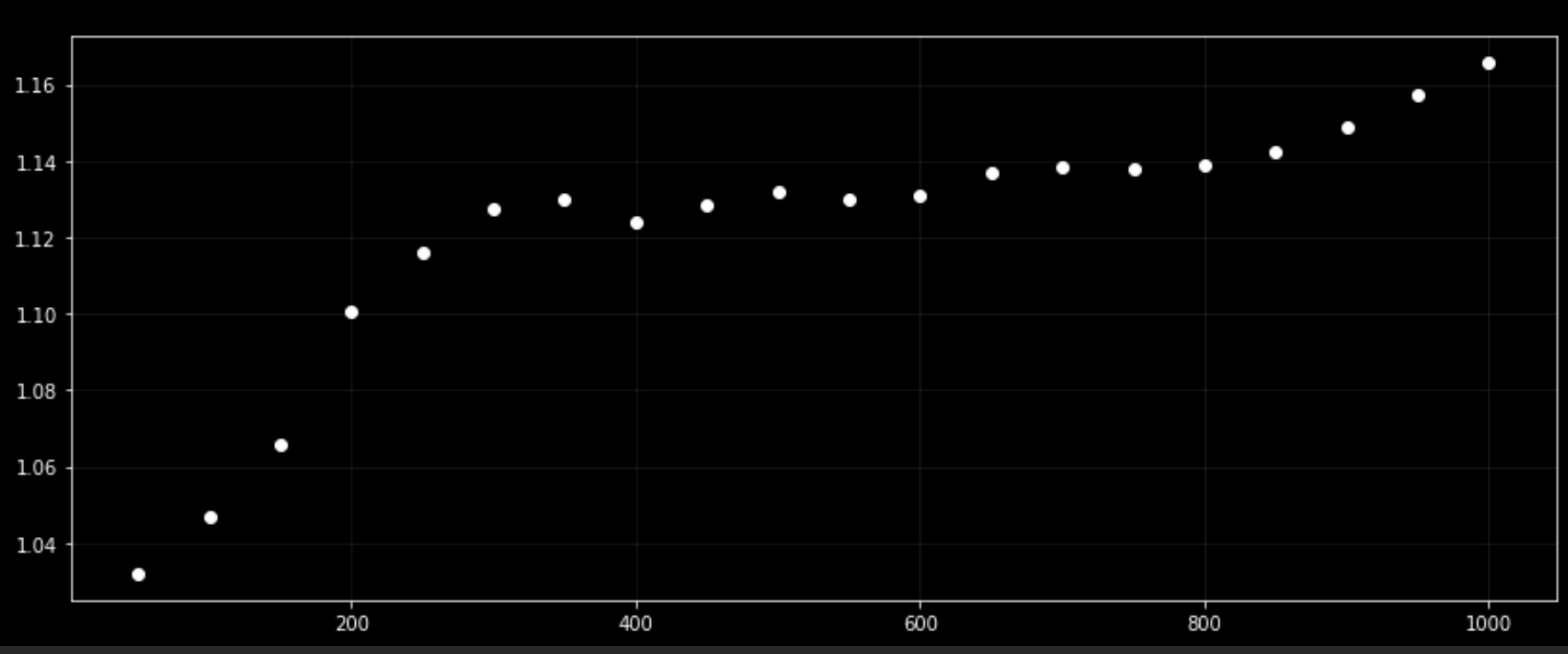
or $X_t = \mu + X_{t-1} + \varepsilon_t, \quad E[\varepsilon_t] = 0, \quad \text{for all } t,$ (1a)

$\Delta X_t = \mu + \varepsilon_t, \quad \Delta X_t \equiv X_t - X_{t-1},$ (1b)

$H_1: \quad \varepsilon_t \text{ i.i.d. } N(0, \sigma^2).$ (2)

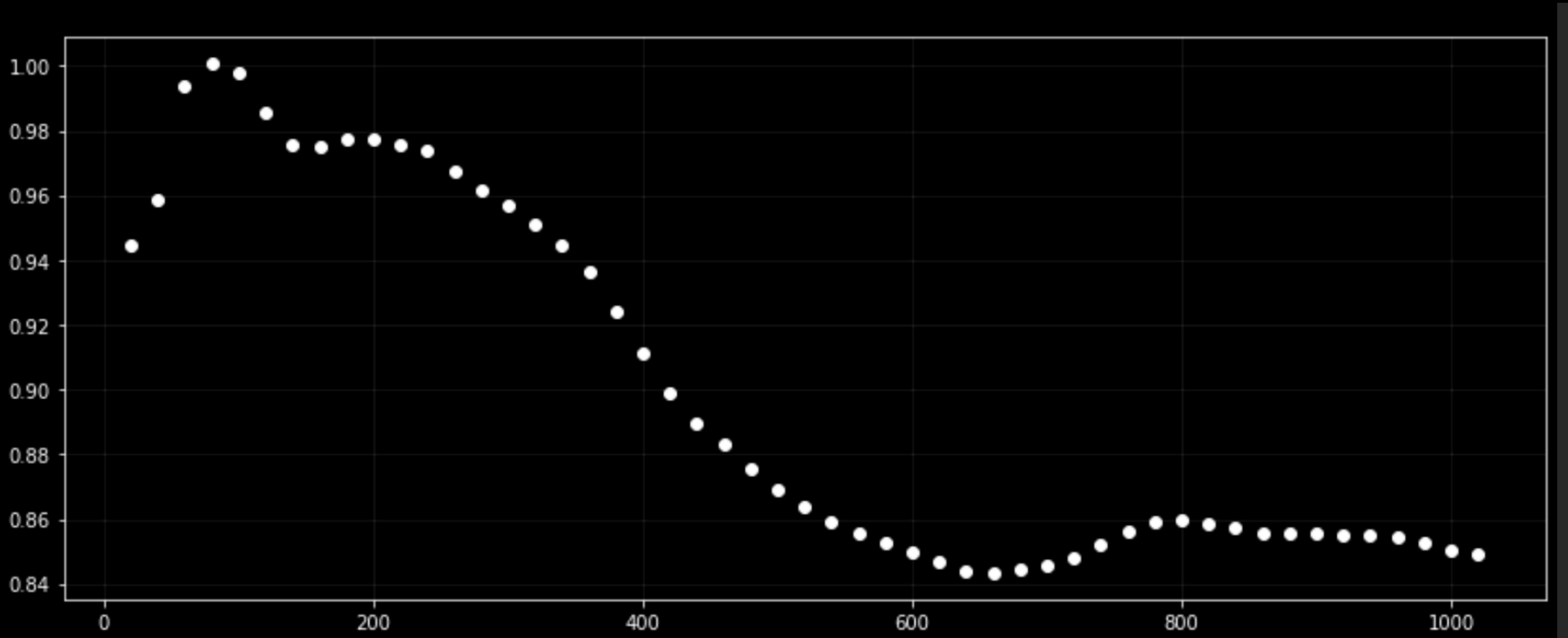
Сравнение данных с Семеном

2012-05-15 - 2012-10-5



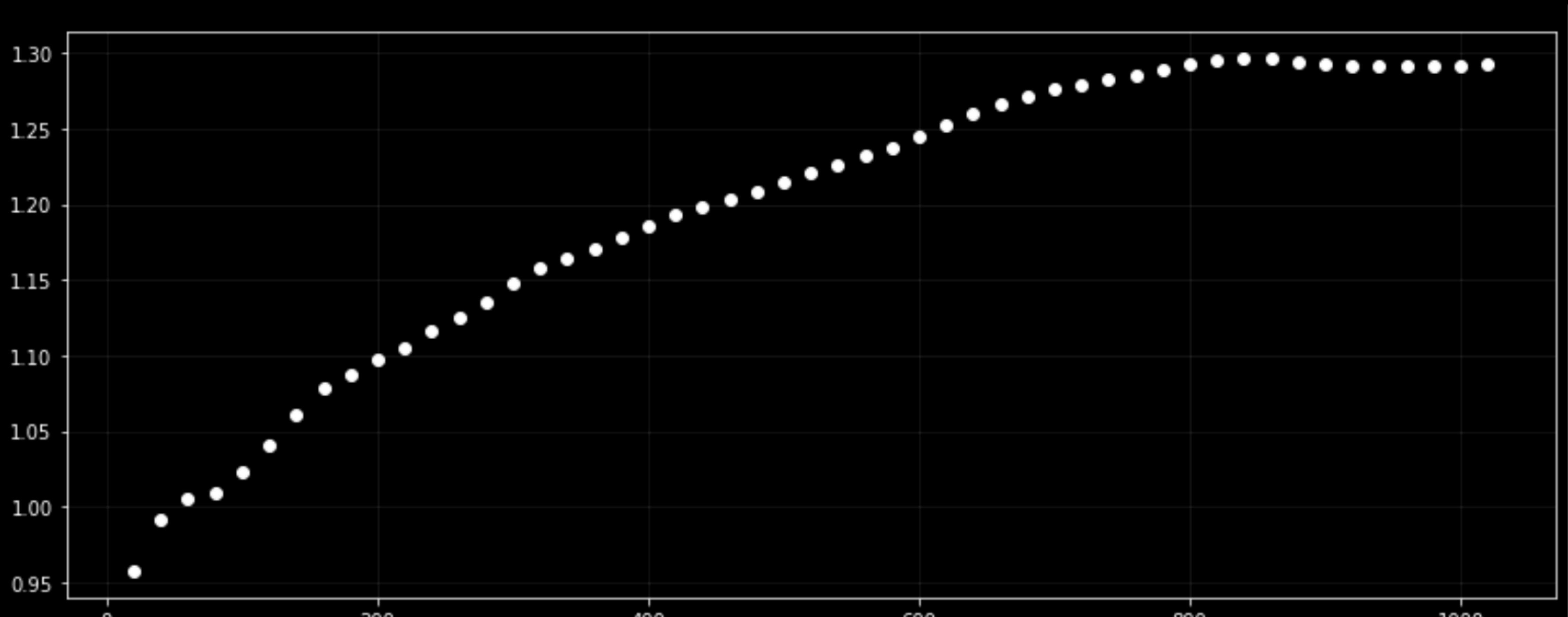
Сравнение данных с Семеном

2011-12-19 - 2012-05-15



Сравнение данных с Семеном

2012-10-05 - 2013-04-01



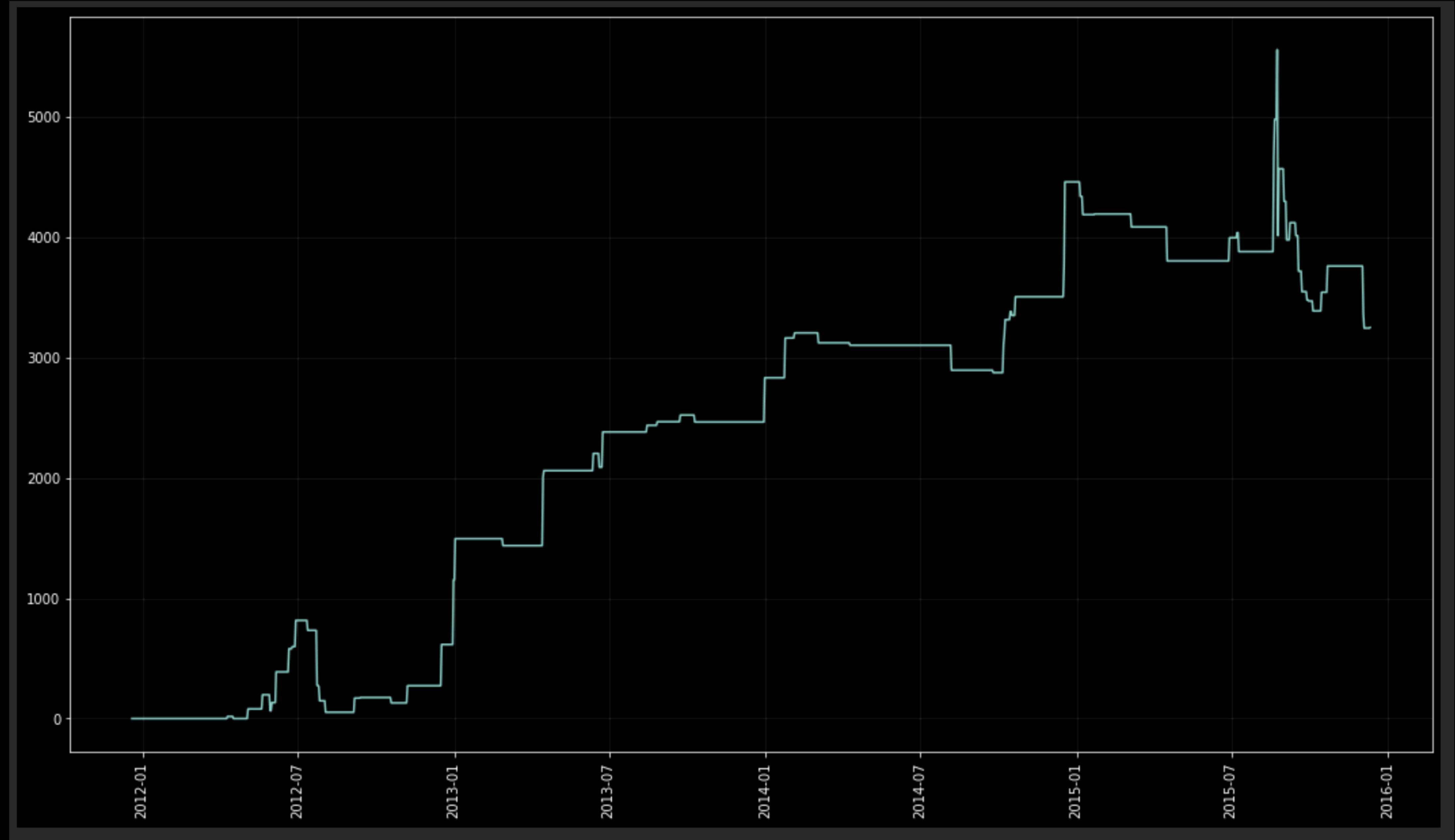
Backtasting

	0	1
0	HOLD	120.000
1	LOOKBACK	1.000
2	THRESHOLD	0.012
3	STOP_LOSS_PERCENT	0.004
4	LOOKBACK_THROUGH_WEEKENS	209.000
5	LOOKBACK_NORMAL	693.000
6	SUMMARY_TRADE_DAYS	902.000
7	TOTAL_TRADES	96.000
8	SHORT_TRADES	47.000
9	LONG_TRADES	49.000
10	STOP_LOSS_TRADES	19.000

SHARPE: 1.588

	0	1
0	HOLD	45.000
1	LOOKBACK	1.000
2	THRESHOLD	0.014
3	STOP_LOSS_PERCENT	1.000
4	LOOKBACK_THROUGH_WEEKENS	209.000
5	LOOKBACK_NORMAL	693.000
6	SUMMARY_TRADE_DAYS	902.000
7	TOTAL_TRADES	77.000
8	SHORT_TRADES	39.000
9	LONG_TRADES	38.000
10	STOP_LOSS_TRADES	0.000

SHARPE: 1.851



		0	1
0	HOLD	45.000	
1	LOOKBACK	1.000	
2	THRESHOLD	0.014	
3	STOP_LOSS_PERCENT	0.004	
4	LOOKBACK_THROUGH_WEEKENS	209.000	
5	LOOKBACK_NORMAL	693.000	
6	SUMMARY_TRADE_DAYS	902.000	
7	TOTAL_TRADES	77.000	
8	SHORT_TRADES	39.000	
9	LONG_TRADES	38.000	
10	STOP_LOSS_TRADES	7.000	

SHARPE: 1.607

