

# Week04 Assignment

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## 1 Problem1

$$\begin{aligned}P_t &= P_{t-1} + r_t \\E(P_t) &= E(P_{t-1}) + E(r_t) = P_{t-1} \\Var(P_t) &= Var(P_{t-1}) + Var(r_t) = \sigma^2\end{aligned}\tag{1}$$

$$\begin{aligned}P_t &= P_{t-1}(1 + r_t) \\E(P_t) &= E(P_{t-1}(1 + r_t)) = P_{t-1}(1 + E(r_t)) = P_{t-1} \\Var(P_t) &= Var(P_{t-1}(1 + r_t)) = P_{t-1}^2\sigma^2\end{aligned}\tag{2}$$

$$\begin{aligned}P_t &= P_{t-1}e^{r_t} \\E(P_t) &= E(P_{t-1}e^{r_t}) = P_{t-1}E(e^{r_t}) = P_{t-1}e^{\mu + \frac{1}{2}\sigma^2} \\Var(P_t) &= Var(P_{t-1}e^{r_t}) = P_{t-1}^2Var(e^{r_t}) = P_{t-1}^2(e^{\sigma^2} - 1)e^{2\mu + \sigma^2}\end{aligned}\tag{3}$$

Classical Brownian Motion:

mean: 10.00024525468145

std: 0.009852316885855281

Expectation:

mean: 10 difference: 0.0002452546814506462

std: 0.01 difference: -0.00014768311414471887

Arithmetic Return System:

mean: 9.998367145374376

std: 0.1024923953908439

Expectation:

mean: 10 difference: -0.001632854625624347

std: 0.1 difference: 0.0024923953908438934

Geometric Brownian Motion:

mean: 9.998319913345714

std: 0.09949480292518091

Expectation:

mean: 10.000500012500208 difference: -0.0021800991544935755

std: 0.10000750030211356 difference: -0.0005126973769326443

## 2 Problem2

Normal Distribution:

5% VaR: -5.42%

1% VaR: -7.66%

Normal Distribution with an Exponentially Weighted Variance:

5% VaR: -3.27%

1% VaR: -4.62%

MLE fitted T Distribution:

5% VaR: -2.9%

1% VaR: -4.11%

Fitte AR(1) Model:

5% VaR: -0.76%

1% VaR: -0.83%

Historic Simulation:

5% VaR: -22.55%

1% VaR: -24.16%

## 3 Problem3

-----EWMA-----

Symbol 5% VaR 1% VaR Arithmetic 5% VaR Geometric 5% VaR

0 SPY -1.05% -1.49% -4.053365 -4.032079

1 AAPL -1.69% -2.39% -2.621957 -2.599890

2 MSFT -1.83% -2.59% -4.644755 -4.602480

3 AMZN -2.37% -3.35% -3.017321 -2.981900

4 NVDA -3.28% -4.64% -4.471406 -4.398882

.. ... ..

96 LRCX -2.71% -3.83% -11.450139 -11.296544

97 ZTS -1.82% -2.58% -2.834646 -2.808982

98 C -1.71% -2.42% -0.798769 -0.791984

99 BSX -1.23% -1.74% -0.497205 -0.494164

100 AMT -1.8% -2.54% -4.374174 -4.335101

[101 rows x 5 columns]

Arithmetic Total VaR: -362.432911810523

Geometric Total VaR: -359.02848745056394

-----Monte Carlo-----

Symbol 5% VaR 1% VaR Arithmetic 5% VaR Geometric 5% VaR

0 SPY -1.06% -1.49% -4.063846 -4.042451

1 AAPL -1.59% -2.25% -2.467194 -2.447649

2 MSFT -1.92% -2.72% -4.868885 -4.822445

3 AMZN -2.37% -3.35% -3.021181 -2.985671

4 NVDA -3.34% -4.73% -4.556723 -4.481421

.. ... ..

96 LRCX -2.63% -3.72% -11.138567 -10.993182

97	ZTS	-1.86%	-2.63%	-2.891639	-2.864936
98	C	-1.77%	-2.5%	-0.826620	-0.819354
99	BSX	-1.24%	-1.76%	-0.502747	-0.499639
100	AMT	-1.75%	-2.48%	-4.264427	-4.227285
[101 rows x 5 columns]					
				Arithmetic Total VaR:	-358.28488443025043
				Geometric Total VaR:	-354.96695189354193
-----Historical-----					
Symbol 5% VaR 1% VaR					
Arithmetic 5% VaR Geometric 5% VaR					
0	SPY	-1.01%	-1.44%	-3.903027	-3.883288
1	AAPL	-1.7%	-2.41%	-2.639270	-2.616912
2	MSFT	-1.72%	-2.43%	-4.353834	-4.316675
3	AMZN	-2.23%	-3.15%	-2.841246	-2.809825
4	NVDA	-3.56%	-5.04%	-4.858512	-4.772968
..	...	...	...	...	...
96	LRCX	-2.72%	-3.85%	-11.515370	-11.360029
97	ZTS	-1.74%	-2.46%	-2.711432	-2.687945
98	C	-1.75%	-2.47%	-0.817839	-0.810727
99	BSX	-1.23%	-1.74%	-0.498718	-0.495659
100	AMT	-1.67%	-2.37%	-4.070106	-4.036263
[101 rows x 5 columns]					
				Arithmetic Total VaR:	-358.0565073942368
				Geometric Total VaR:	-354.70430245091774