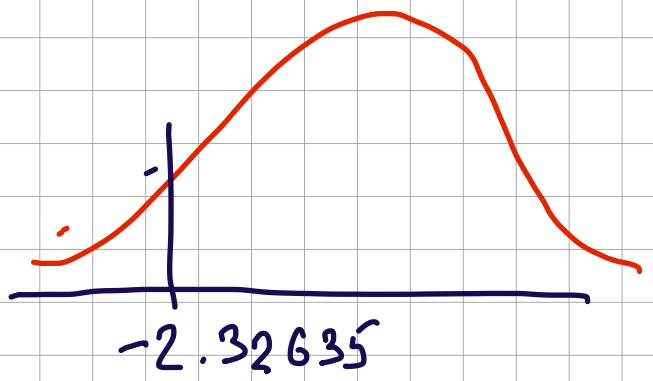
Analytical VaR 99%, 10D



Standardised Returns, z_t

-3
-2.91
-2.33
-2.18
-1.98
+3

2-score

$$z_t = \frac{r_t - \mu}{\sigma}$$

historic sample

Returns $r_{t,10}$ v_t

-0.15
-0.14
-0.12
-0.10
...
0.01
0.025
...
0.11
...

$N_{obs} = 200$

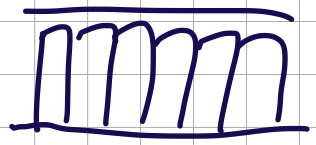
Monte-Carlo VaR

Ks-density

- kernel function ... $e^{x^2/2}$ for pdf
- numerically integrate over pdf to get CDF

Pseudo-samples

0
0.005
0.011
...
1



$v_t = F_X(x_t)$

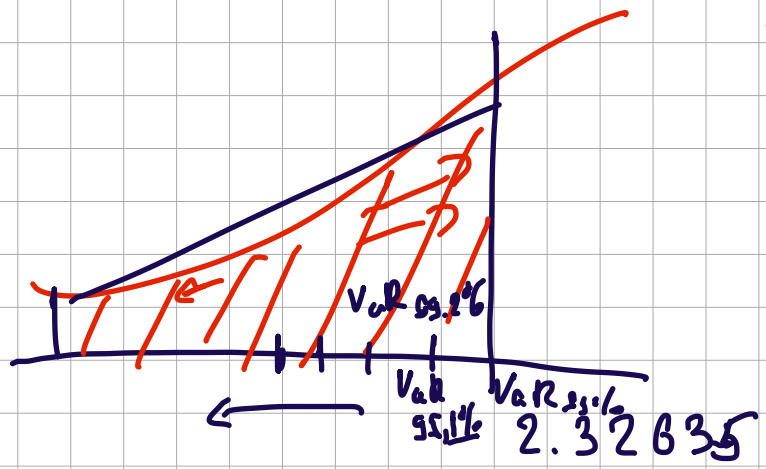
R CDF

Historic VaR

$VaR_{99\%} = -0.14$

PERCENTILE()

Expected Shortfall



$$ES_c(X) = \mathbb{E}[X \mid x \le VaR_c(X)]$$

average of a tail

$$ES_c = \frac{1}{1-c} \int_0^{1-c} VaR_u \, du$$

$$= \underbrace{\frac{1}{0.01} \sum VaR}_{\text{averaging}}$$

$$VaR_{99\%} = -0.14$$

$$ES_{99\%} = -\frac{0.15 - 0.14}{2}$$

$$= -0.145$$