

1. Given initial  $\lambda_0 = \hat{\lambda}_0 \times 10^{k_0}$ ,  $\hat{\lambda}_0$  must be 1, I'll start from  $\lambda_0 = 1$ .
2. Search in range  $[\lambda_0 - 10^{k_0}, \lambda_0 + 10^{k_0}]$ , step =  $10^{k_0-1}$ , find the  $\lambda$  in above 20 values that makes  $TestR^2$  are biggest as  $\lambda_1$ , represent  $\lambda_1$  as  $\lambda_1 = \hat{\lambda}_1 \times 10^{k_1}$ .
3. Repeat process 2, until  $k_n = k_{n-1}$ , then  $\lambda_n$  was selected as the best  $\lambda$ .

To prevent another  $\lambda$  to make  $TestR^2$  get bigger suddenly after finish 3, I'll use  $\lambda = \{10^{k_n}, 10^{k_n-1}, 10^{k_n-2} \dots\}$  to do step 2 a few more times, how many times was depends on the observation of  $TestR^2$ .

For example:

$\lambda_0 = 1 = 1 \times 10^0$ , then searching in  $\{0.1, 0.2, 0.3, \dots, 2\}$  suppose that  $\Rightarrow$   
 $\lambda_1 = 0.1 = 1 \times 10^{-1}$ , then search in  $\{0.01, 0.02, \dots, 0.2\}$ , suppose that  $\Rightarrow$   
 $\lambda_2 = 0.03 = 3 \times 10^{-2}$ , then search in  $\{0.021, 0.022, \dots, 0.4\}$ , suppose that  $\Rightarrow$   
 $\lambda_3 = 0.022 = 2.2 \times 10^{-2}$ ,  $k_2 = k_3$ , so take the  $\lambda_3$  as best  $\lambda$