Regularization to combat the overfitting issue



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Overfitting and Regularization

Overfitting

When the sample size is strictly smaller than the input dimension d, there are infinite many θ such that

$$L(\theta|X,Y) = (Y - X\theta)^{T}(Y - X\theta) = 0,$$

and it leads to little predictive power of the estimated model in the testing dataset.

Regularization

In order to resolve the overfitting issue here, we consider the constraint optimization problem

$$\min_{\beta} (Y - X\beta)^T (Y - X\beta)$$
, s.t. $||\beta|| \le t$.



2/5

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From constraint optimization to unconstraint optimization

Lagrange multiplier

We reformulate the above constraint optimization problem as the following unconstraint one by Lagrange multiplier:

$$\min_{\lambda,\theta} L_{\mathsf{new}}(\lambda,\theta|X,Y)$$

where

$$L_{\text{new}}(\lambda, \theta|X, Y) := (Y - X\theta)^T (Y - X\theta) + \lambda(||\theta|| - t).$$

Therefore, it suggests us to consider the following modified loss function

$$\tilde{L}_{\lambda}(\theta|X,Y) = (Y - X\theta)^{T}(Y - X\theta) + \lambda||\theta||,$$

where $\lambda > 0$ is a model hyper-parameter. [1, 2]

3/5

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Regularization

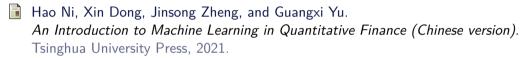
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Thanks for your attention!

4/5

References I



Hao Ni, Xin Dong, Jinsong Zheng, and Guangxi Yu. An Introduction to Machine Learning in Quantitative Finance (English version). World Scientific, 2021.

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