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Pullout capacity of small ground anchor: a least square support vector machine approach

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Details of LSSVM

Training vector:

$$x=\left[D_{eq},L,q_c,f_s,\mathrm{IT}\right] \quad y=\left[Q\right]$$

$$\mathbf{D}=\left\{\left(\mathbf{x^1},\mathbf{y^1}\right),\ldots,\left(\mathbf{x^l},\mathbf{y^l}\right)\right\}$$

The data has been taken from the work of Shahin and Jaksa, (2006).

According to LSSVM: $y(x)=w^T\varphi(x)+b$

Where the nonlinear mapping $\varphi(\cdot)$ maps the input data into a higher dimensional feature space, w = an adjustable weight vector and b =scalar threshold.

Optimization problem

Minimize: $\frac{1}{2}w^T w+\gamma\frac{1}{2}\sum_{k=1}^{N}e_k^2$

Subjected to: $y(x)=w^T\varphi(x_k)+b+e_k$,k=1,…,N

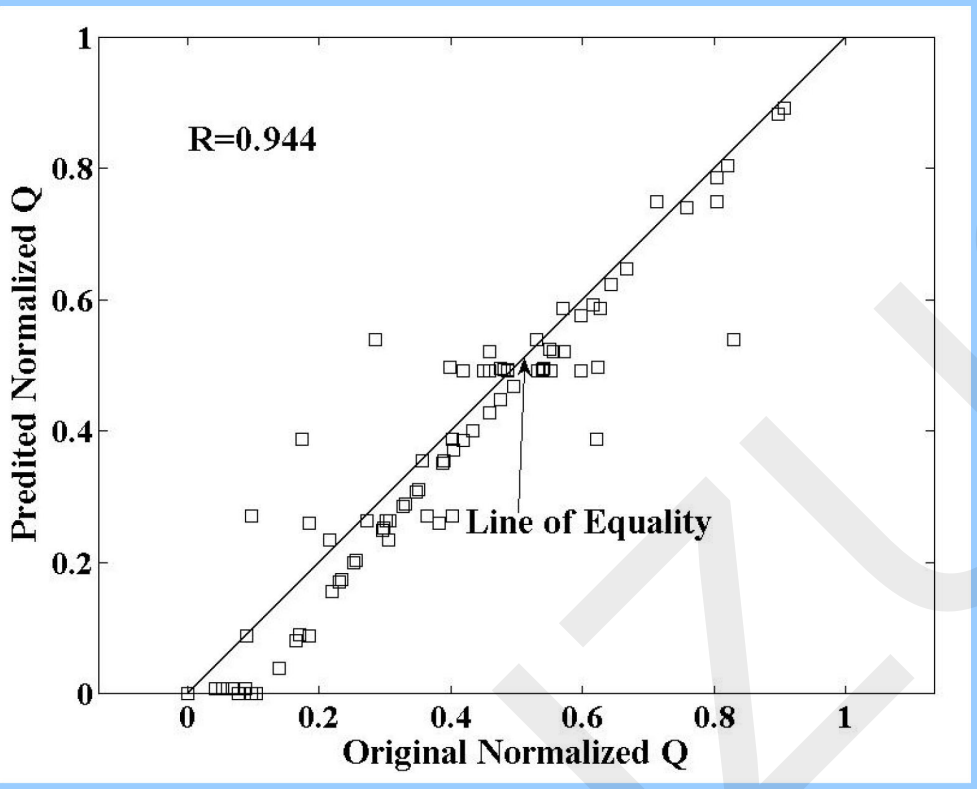
Where γ is the regularization parameter, determining the trade-off between the fitting error minimization and smoothness and e_k is error variable.

The resulting equation from LSSVM model for Q prediction:

$$Q=y(x)=\sum_{k=1}^{N}\alpha_k K(x,x_k)+b$$

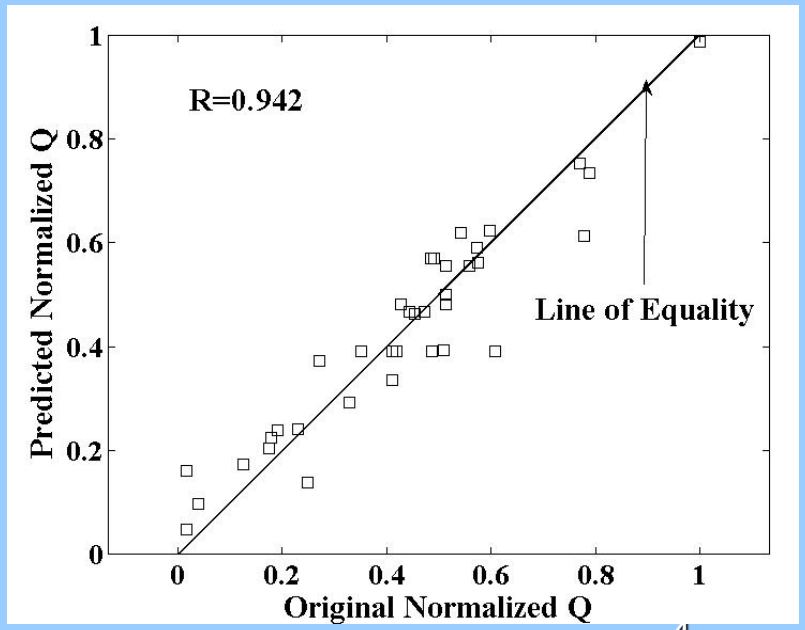
Where $K(x_i, x)$ is a kernel function, and α_i Lagrange multipliers

Performance of LSSVM



Training Data=83

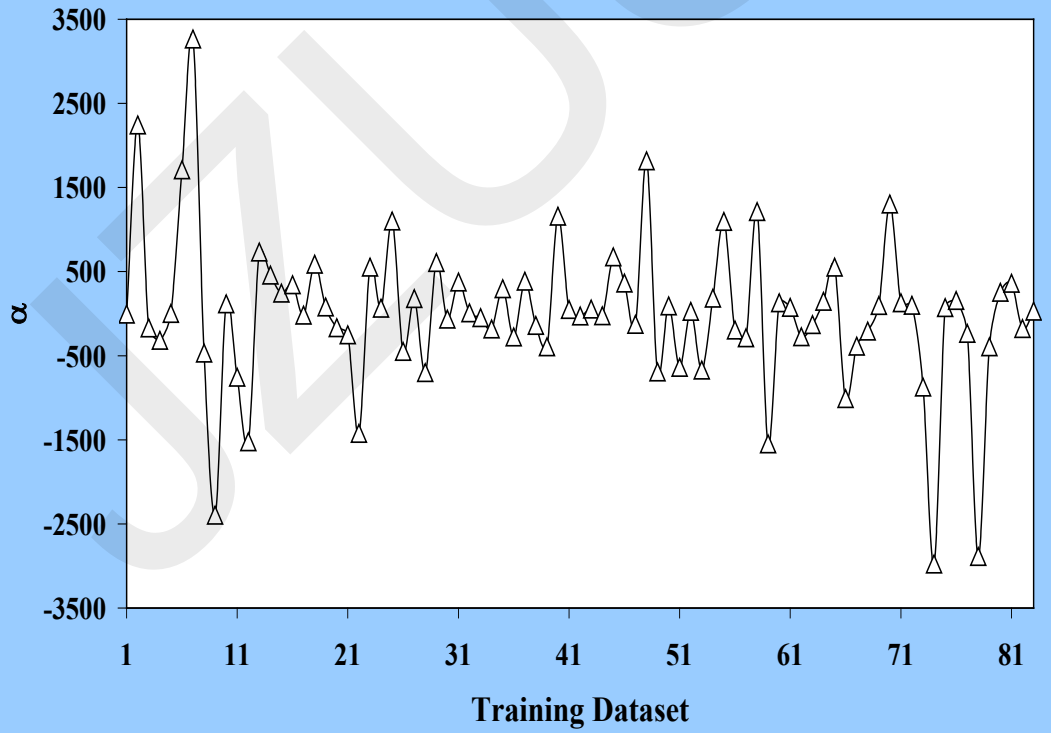
Testing Data=36



Equation for Prediction of Q

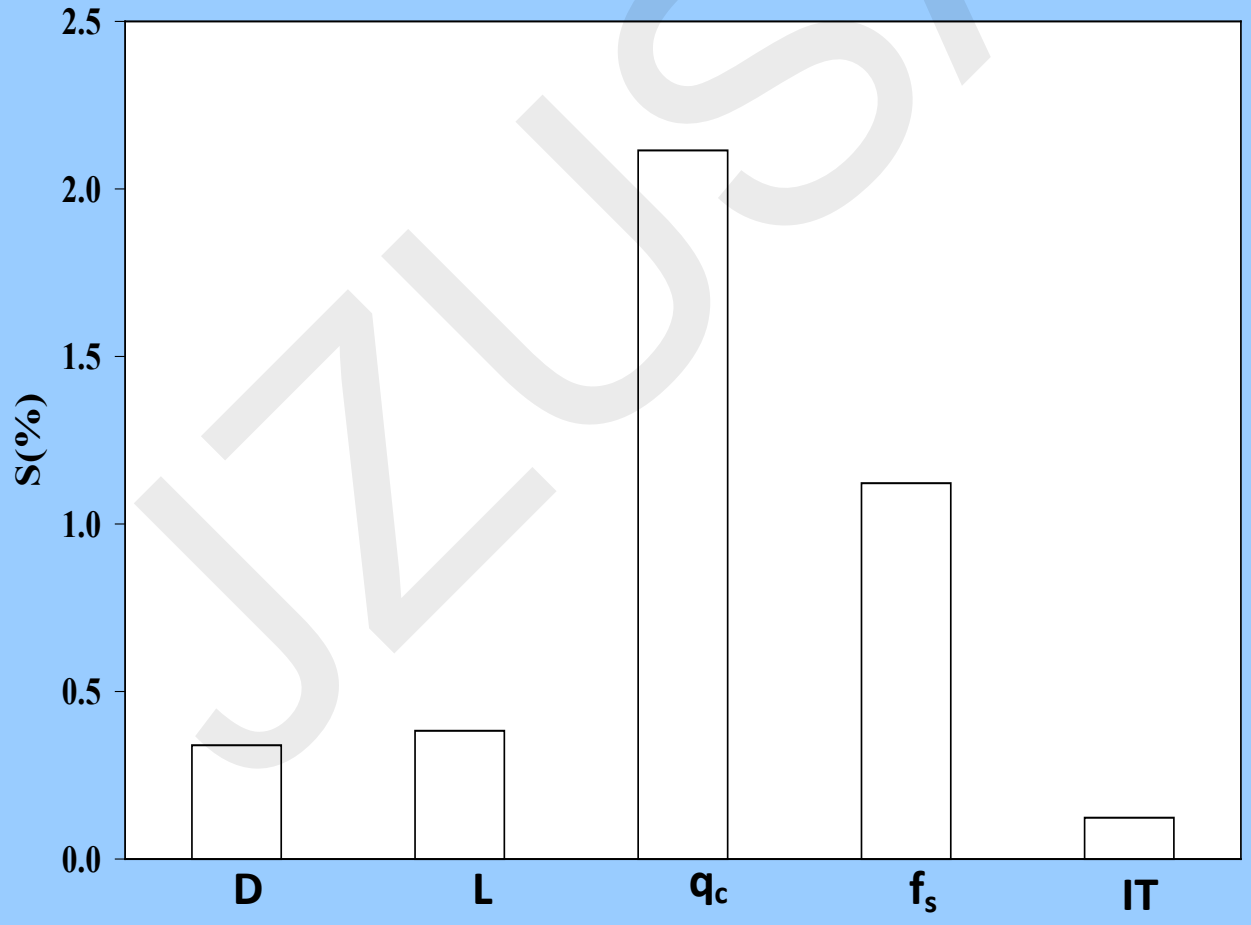
Geotechnical engineers can use the following equation for prediction of Q

$$Q = \sum_{k=1}^{83} \alpha_k \exp\left\{-\frac{(x_i - x)(x_i - x)^T}{98}\right\} - 3.8239$$



Sensitivity analysis

$$S(\%)=\frac{1}{N}\sum_{j=1}^{N}\left(\frac{\%\ \text{change in ouput}}{\%\ \text{change in input}}\right)_j\times 100$$



Conclusion

- The developed LSSVM gives better performance than the ANN
- User can use the developed equation for practical purpose
- Sensitivity analysis indicates that q_c is the most significant input parameter for predicting Q of small ground anchor.