Lucerne University of
Applied Sciences and Arts

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**Informatik**
FH Zentralschweiz

# ML: Regularization - Exercises

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Please write down to solution of the exercises in a consise but comprehensible way (including intermediate results). Numerical results should be accurate to 4 digits. Sketches should be correct qualitatively.

At least 75% of the exercises have to be solve satisfactorily. Due time is May 1st, 2018. The first exercise should be handed in via E-Mail to `Josef.Buergler@hslu.ch`.

## Exercise 1: Simple Example from Lecture (1 Point)

Add a section to the Jupyter Notebook `Ridge+LASSO_Regression.ipynb` that finds the optimal regularization hyperparameter $\lambda$. In order to do so, we will use LASSO regression and proceed as follows:

1. For every value $\lambda_0 = 0$, $\lambda_1 = 0.01$ and from there always double $\lambda$ until You have reached a point, where to cross validation error starts to grow again (due to overfitting). So $\lambda_{12} = 10.24$ is the 12th value of $\lambda$ but it need not be the largest in this example.
   a) Using the training set compute
   $$\boldsymbol{\theta}_k = \underset{\boldsymbol{\theta}}{\operatorname{argmin}} \left(J_{\text{train}}(\boldsymbol{\theta}) + \lambda\Omega(\boldsymbol{\theta})\right) \qquad \text{where } k \text{ is one of the numbers } 1,2,3,\ldots$$
   Then compute the error in the cross validation set
   $$\left(J_{\text{cv}}(\boldsymbol{\theta}_k) + \lambda\Omega(\boldsymbol{\theta}_k)\right)$$
   b) Plot these errors for this value of $\lambda$.
2. Once You notice the growing tendency of the error in the cross validation set depending on the regularization parameter $\lambda$ stop after the next larger value of $\lambda$
3. Find the value for $\lambda$ which leads to the smallest cross validation error.
4. print the corresponding coefficients of the regression polynomial and draw it.

## Exercise 4: Real Word Examples (1 Point)

Fill in the missing sections in the Real World Example of `regularization_gaps.ipynb` and make the Jupyter Notebook runnable. Hand it in via E-Mail to Tim vor der Brück (E-Mail-Address: `tim.vorderbrueck@hslu.ch`) no later than Tuesday, May 1st, 2018.

**Happy Machine Learning !**