DATA.ML.200 Pattern Recognition and Machine Learning

Exercise Set 4: Linear models in machine learning

Be prepared for the exercise sessions (watch the demo lecture). You may ask TAs to help if you cannot make your program to work, but don't expect them to show you how to start from the scratch.

1. **python** *Scikit-Learn Logistic Regression. (5 pts)*

   Download two-dimensional samples in the data file "X.dat" and the ground truth classes in "y.dat" ($y = \{-1, +1\}$).

   Using this dataset, train Scikit-Learn logistic regression model (`https://scikit-learn.org/stable/modules/generated/sklearn.linear_model.LinearRegression.html`) and report its classification accuracy for the training data.

   Switch off the penalty term (penalty='none') and do not use intercept (fit_intercept=False). The final weights are stored into variable "classifier.coef_" (w_1 and w_2) which you can plot using different number of iterations to see where they converge.

2. **python** *Logistic Regression with SSE. (5 pts)*

   Now implement the basic logistic regression gradient descent learning rule yourself. Use the SSE update rule for which you derived the gradient in your homework. Run iterative optimization for 100 steps with the learning rate $\mu = 0.001$ and starting from $\vec{w}^0 = (w_1,\ w_2)^T = (1,\ -1)^T$.

   To verify that your method converges to the same point as the Scikit-learn LR, plot the weight trajectory over the iterations (see Figure 1 for example).

3. **python** *Logistic Regression with ML. (5 pts)*

   Implement the same optimizationn using now the ML update rule and your log-loss gradient. Inspect whether SSE and ML loss optimization follow the same trajectory or not.

   Note: For your own optimization you may need to normalize your data. At least remove the mean vector from training samples. This simple gradient descent optimization is sensitive to different scales of the input features. The better optimization routines of Scikit-learn handle data better.

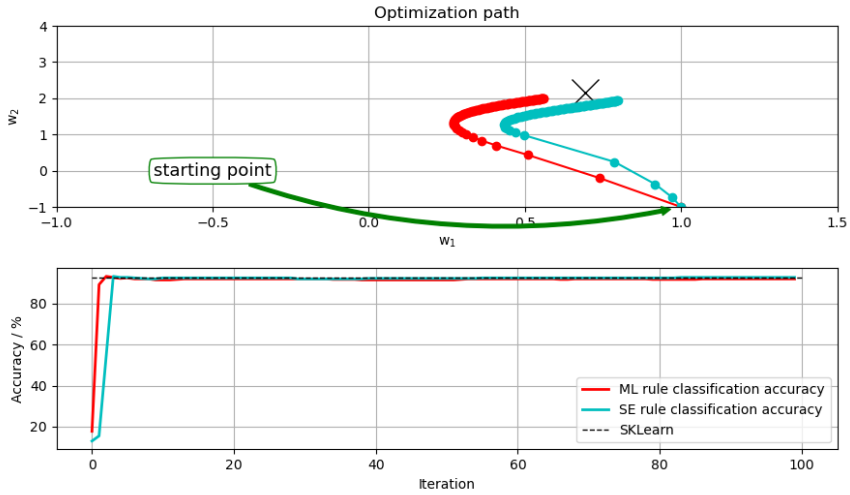

Figure 1: Example of what your code should produce.

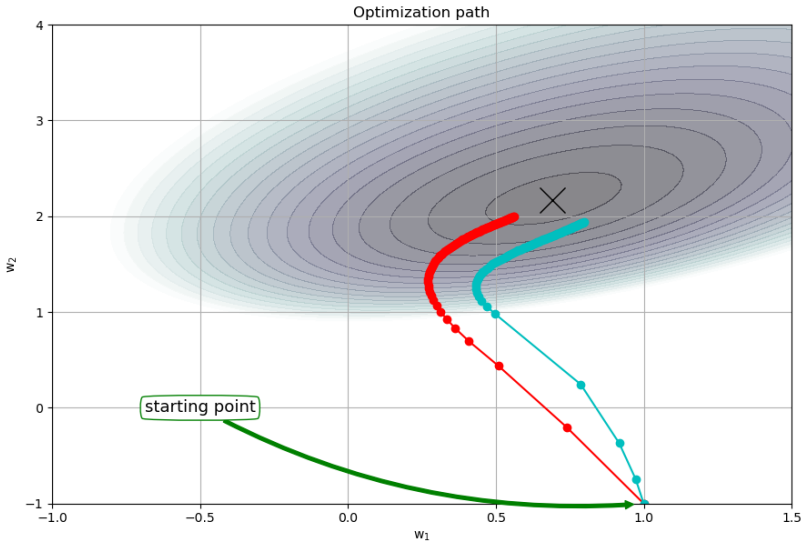

Figure 2: A more detailed example with log-loss values visualized (no need to reproduce this).