

Points 200; Due: Dec 5 midnight

IMPORTANT: Students submitting a non-Word or non-pdf file will get a zero.

This project is on implementing linear regression with regularization, with the regularization parameter estimated from cross-validation. Do not use any package; write code from scratch, except the use of a random number generator. Use the function $y = f(x) = x^2 + 10$ to create a random sample (x_j, y_j) (training data) of size 12 (that is, $j = 1$ to 12), by uniform random sampling of x in $-2 \leq x \leq 10$.

1. Obtain a linear regression of y on x . First use linear regression **without** regularization.
2. Next, implement linear regression with regularization (use “ridge” regression, $\lambda \sum_i w_i^2$), obtaining your λ from 3-fold cross validation. Try the following values of λ and choose one using cross-validation: 0.1, 1, 10, 100.
3. [This part for the graduate section only] Finally, replace ridge in part 2 above with “lasso,” $\lambda \sum_i |w_i|$, and re-do the computation .

Clearly write the following in your report (in addition to the source code):

- (a) The twelve (x,y) values.
- (b) The equation of the regression relation you obtained in part 1.
- (c) The value of λ and the corresponding in-sample error and cross-validation error (four such triplets) in part 2 (also in part 3 for grad students).
- (d) The final λ you chose after performing cross-validation in part 2 (and 3).
- (e) The final equation of the regression relation you obtained after regularization. And the corresponding (final) in-sample error.

Plot your data points and the final solutions by hand (or use a plotting software; but no extra credit for using the software). Specifically, your plot should show 12 points on the x - y plane and two (three for graduate students) final lines (along with their equations).

Note that our x here is one-dimensional.

Please do not use any package; write C/C++/Java/Python code to implement everything from scratch. Please submit a single pdf (or Word) file on MyGateway. Please write legibly if you are submitting any hand-written (and scanned) stuff.