Contents

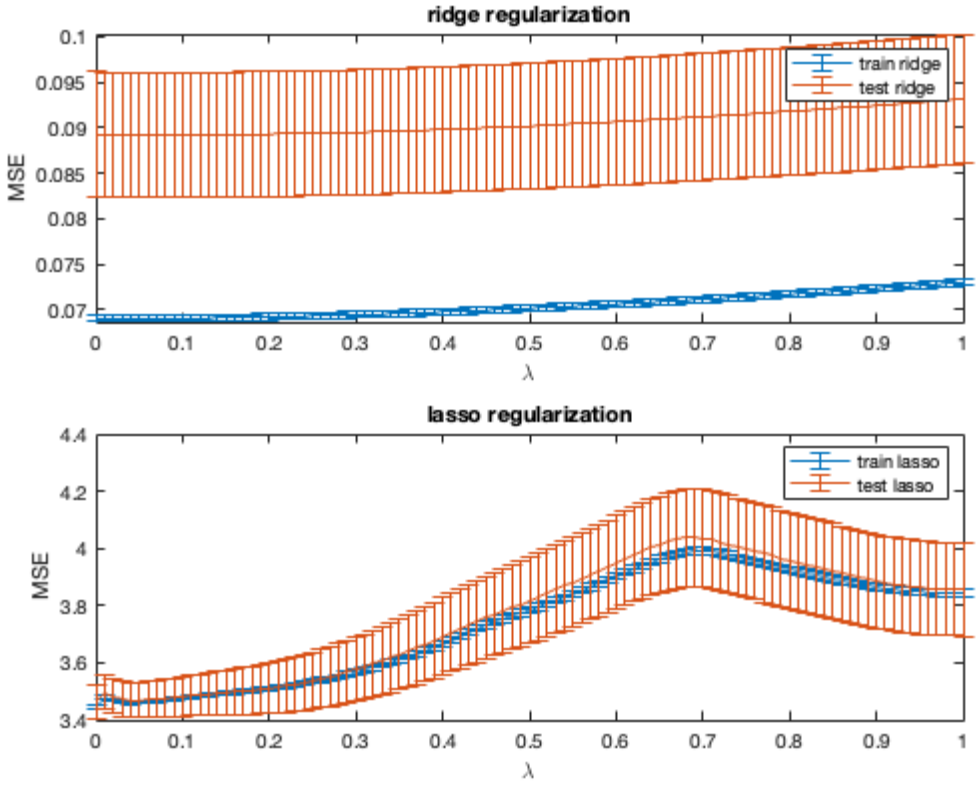

```
clear; close all; clc;
```

a)

```
load('regress1.mat')

X = [x.^0 x.^1 x.^2 x.^3 x.^4 x.^5];% x.^6 x.^7 x.^8 x.^9];
train_size = floor(0.95 * size(X, 1));

lambdas = 0:0.01:1;
cv_times = 1e3;
mse_train_ridge = zeros(cv_times, length(lambdas));
mse_test_ridge = zeros(cv_times, length(lambdas));
mse_train_lasso = zeros(cv_times, length(lambdas));
mse_test_lasso = zeros(cv_times, length(lambdas));

beta_lasso_ = zeros(cv_times, size(X, 2), length(lambdas));
beta_ridge_ = zeros(cv_times, size(X, 2), length(lambdas));

for i = 1:cv_times
    train_indices = randperm(size(X, 1), train_size);
    test_indices = setdiff(1:size(X, 1), train_indices);
    X_train = X(train_indices, :);
    X_test = X(test_indices, :);
    y_train = y(train_indices);
    y_test = y(test_indices);

    beta_lasso_train = lasso(X_train, y_train, 'Lambda', lambdas, ...
        'Intercept', true, 'Standardize', false);
    beta_lasso_(i, :, :) = beta_lasso_train;
    for ll = 1:length(lambdas)
        lambda = lambdas(ll);

        % ridge regression
        beta_ridge_train = ridge_reg(X_train, y_train, lambda);
        beta_ridge_(i, :, ll) = beta_ridge_train;
        %betas_ridge(, :) = beta_ridge_train;
        y_pred_train_ridge = X_train * beta_ridge_train;
        y_pred_test_ridge = X_test * beta_ridge_train;
        mse_train_ridge(i, ll) = mean((y_train - y_pred_train_ridge).^2);
        mse_test_ridge(i, ll) = mean((y_test - y_pred_test_ridge).^2);

        % lasso regression
        y_pred_train_lasso = X_train * beta_lasso_train(:, ll);
        y_pred_test_lasso = X_test * beta_lasso_train(:, ll);
        mse_train_lasso(i, ll) = mean((y_train - y_pred_train_lasso).^2);
        mse_test_lasso(i, ll) = mean((y_test - y_pred_test_lasso).^2);
    end
end

mean_mse_train_ridge = mean(mse_train_ridge, 1);
mean_mse_test_ridge = mean(mse_test_ridge, 1);
stderror_mse_train_ridge = std(mse_train_ridge, 1)./sqrt(size(X, 1));
```

```
stderror_mse_test_ridge = std(mse_test_ridge, 1)./sqrt(size(X, 1));

mean_mse_train_lasso = mean(mse_train_lasso, 1);
mean_mse_test_lasso = mean(mse_test_lasso, 1);
stderror_mse_train_lasso = std(mse_train_lasso, 1)./sqrt(size(X, 1));
stderror_mse_test_lasso = std(mse_test_lasso, 1)./sqrt(size(X, 1));
```

```
figure()
subplot(2, 1, 1)
errorbar(lambdas, mean_mse_train_ridge, stderror_mse_train_ridge, ...
   'DisplayName', 'train ridge')
hold on;
errorbar(lambdas, mean_mse_test_ridge, stderror_mse_test_ridge, ...
    'DisplayName', 'test ridge')
xlabel('\lambda')
ylabel('MSE')
title('ridge regularization')
legend()

subplot(2, 1, 2)
errorbar(lambdas, mean_mse_train_lasso, stderror_mse_train_lasso, ...
    'DisplayName', 'train lasso')
hold on;
errorbar(lambdas, mean_mse_test_lasso, stderror_mse_test_lasso, ...
    'DisplayName', 'test lasso')
xlabel('\lambda')
ylabel('MSE')
title('lasso regularization')
legend()
```



```
[~, ridge_param_index] = min(mean_mse_test_ridge(2: end));
[~, lasso_param_index] = min(mean_mse_test_lasso(2: end));
ridge_lambda_optim = lambdas(ridge_param_index)
lasso_lambda_optim = lambdas(lasso_param_index)

beta_ridge_train_avg = mean(beta_ridge_(:, :, ridge_param_index), 1)
beta_lasso_train_avg = mean(beta_lasso_(:, :, lasso_param_index), 1)
mean_mse_ridge_test_avg = mean(mse_train_ridge(:, ridge_param_index), 1)
mean_mse_lasso_test_avg = mean(mse_train_lasso(:, lasso_param_index), 1)

beta_ridge_train_error = std(beta_ridge_(:, :, ridge_param_index), 0, 1)
beta_lasso_train_error = std(beta_lasso_(:, :, lasso_param_index), 0, 1)
```

```
ridge_lambda_optim =

    0.0700


lasso_lambda_optim =

    0.0300


beta_ridge_train_avg =

   -1.8190   -1.1233   -0.1202    0.1050    0.2422   -0.0298


beta_lasso_train_avg =

         0   -0.9726         0   -0.0001    0.1848   -0.0005


mean_mse_ridge_test_avg =

    0.0690


mean_mse_lasso_test_avg =

    3.4613


beta_ridge_train_error =

    0.0182    0.0243    0.0408    0.0205    0.0176    0.0069


beta_lasso_train_error =

         0    0.0108         0    0.0008    0.0028    0.0013
```

```
train_indices = randperm(size(X, 1), train_size);
test_indices = setdiff(1:size(X, 1), train_indices);
X_train = X(train_indices, :);
```

```
X_test = X(test_indices, :);
y_train = y(train_indices);
y_test = y(test_indices);

beta_ridge_train_optim = ridge_reg(X_train, y_train, ridge_lambda_optim)
beta_lasso_train_optim = lasso(X_train, y_train, 'Lambda', lasso_lambda_optim, ...
        'Intercept', true, 'Standardize', false)
```

```
function beta_ridge = ridge_reg(X, y, lambda)
    beta_ridge = (X' * X + lambda * eye(size(X, 2))) \ (X' * y);
    % beta_ridge = inv(X' * X + lambda * eye(size(X, 2))) * (X' * y);
end
```

Published with MATLAB® R2021b