Project 3 - Group 1 Improvement

Liu Han, Hongyu Ji, Yi Lin, Zehan Wang, Xiaojie Wei

```
if(!require("EBImage")){
  source("https://bioconductor.org/biocLite.R")
  biocLite("EBImage")
}
```

```
## Loading required package: EBImage
```

```
## Warning: package 'EBImage' was built under R version 3.4.3
```

```
if(!require("xgboost")){
  install.packages("xgboost")
}
```

```
## Loading required package: xgboost
```

```
## Warning: package 'xgboost' was built under R version 3.4.4
```

```
library("EBImage")
library("xgboost")
```

Step 0: specify directories.

Set the working directory to the image folder. Specify the training and the testing set. For the test dataset, we use the same train dataset to test our model.

```
#getwd()
set.seed(2018)
# setwd("./ads_fall2018_proj3")
# here replace it with your own path or manually set it in RStudio to where this rmd file is located.
# use relative path for reproducibility
```

Provide directories for training images. Low-resolution (LR) image set and High-resolution (HR) image set will be in different subfolders.

```
train_dir <- "../data/train_set/" # This will be modified for different data sets.
train_LR_dir <- paste(train_dir, "LR/", sep="")
train_HR_dir <- paste(train_dir, "HR/", sep="")
train_label_path <- paste(train_dir, "label.csv", sep="")
```

Step 1: set up controls for evaluation experiments.

In this chunk, we have a set of controls for the evaluation experiments.

- (T/F) cross-validation on the training set
- (number) K, the number of CV folds
- (T/F) process features for training set
- (T/F) run evaluation on an independent test set
- (T/F) process features for test set

```
run.cv=TRUE # run cross-validation on the training set
K <- 3  # number of CV folds
run.feature.train=TRUE # process features for training set
```

```
run.test=TRUE # run evaluation on an independent test set
run.feature.test=TRUE # process features for test set
```

Using cross-validation or independent test set evaluation, we compare the performance of models with different specifications. In this example, we use GBM with different `depth`. In the following chunk, we list, in a vector, setups (in this case, `depth`) corresponding to models that we will compare.

```
model_values <- array(NA, dim=c(2, 12))
model_values[1, ]<- rep(6:9, each=3)
model_values[2, ]<- rep(c(2,5,10), 4)
#rownames(model_values)<- c("Depth", "nrounds")
```

Step 2: import training images class labels.

We provide extra information of image label: car (0), flower (1), market (2). These labels are not necessary for model.

```
extra_label <- read.csv(train_label_path, colClasses=c("NULL", NA, NA))
```

Step 3: construct features and responses

- `feature.R`
- Input: a path for low-resolution images.
- Input: a path for high-resolution images.
- Output: an RData file that contains extracted features and corresponding responses

```
source("../lib/feature.R")

tm_feature_train <- NA
if(run.feature.train){
  tm_feature_train <- system.time(dat_train <- feature(train_LR_dir, train_HR_dir))
  feat_train <- dat_train$feature
  label_train <- dat_train$label
}

save(dat_train, file="../output/feature_train.RData")
```

Step 4: Train a classification model with training images

Call the train model and test model from library.

- `train.R`
- Input: a path that points to the training set features and responses.
- Output: an RData file that contains trained classifiers in the forms of R objects: models/settings/links to external trained configurations.
- `test.R`
- Input: a path that points to the test set features.
- Input: an R object that contains a trained classifier.
- Output: an R object of response predictions on the test set. If there are multiple classifiers under evaluation, there should be multiple sets of label predictions.

```
source("../lib/train.R")
source("../lib/test.R")
```

Model selection with cross-validation

- Do model selection by choosing among different values of training model parameters, that is, the interaction depth for XgBoost in this example.

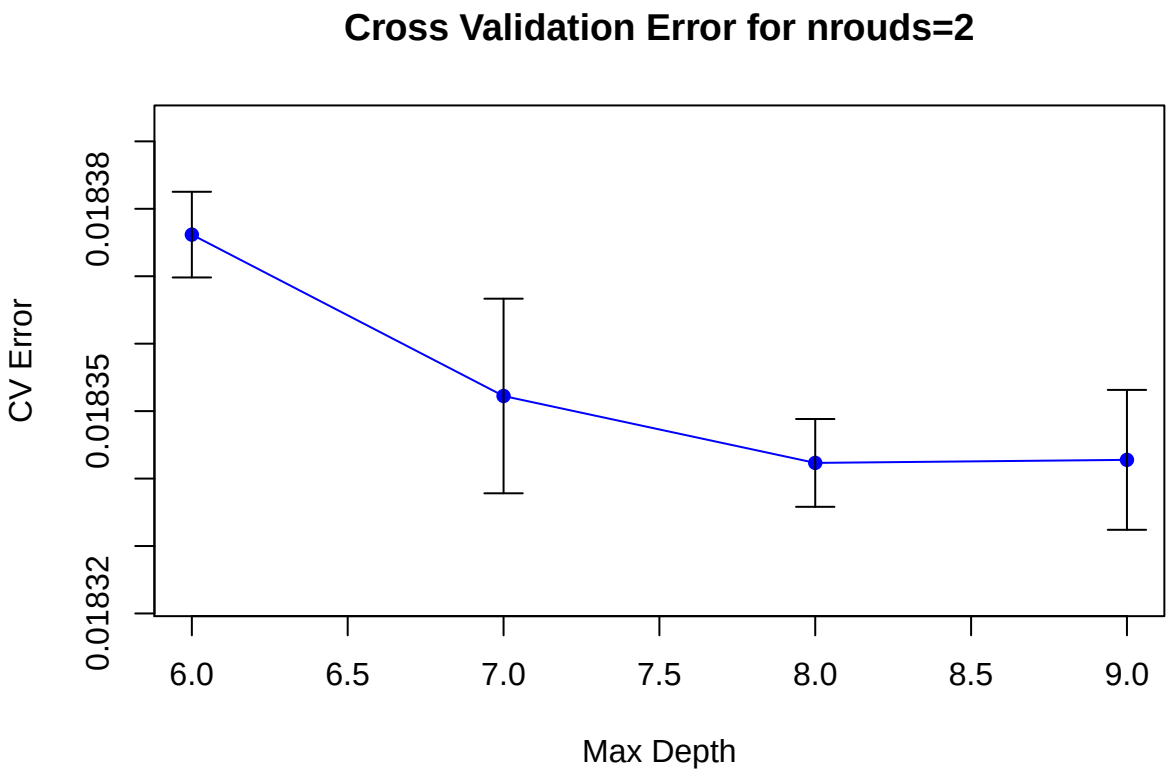
```
source("../lib/cross_validation.R")
if(run.cv){
  err_cv <- array(dim=c(length(model_values[1,]), 2))
  for(k in 1:length(model_values[1,])){
    cat("k=", k, "\n")
    err_cv[k,] <- cv.function(feat_train, label_train, model_values[,k], K)
  }
  save(err_cv, file="../output/err_cv.RData")
}
```

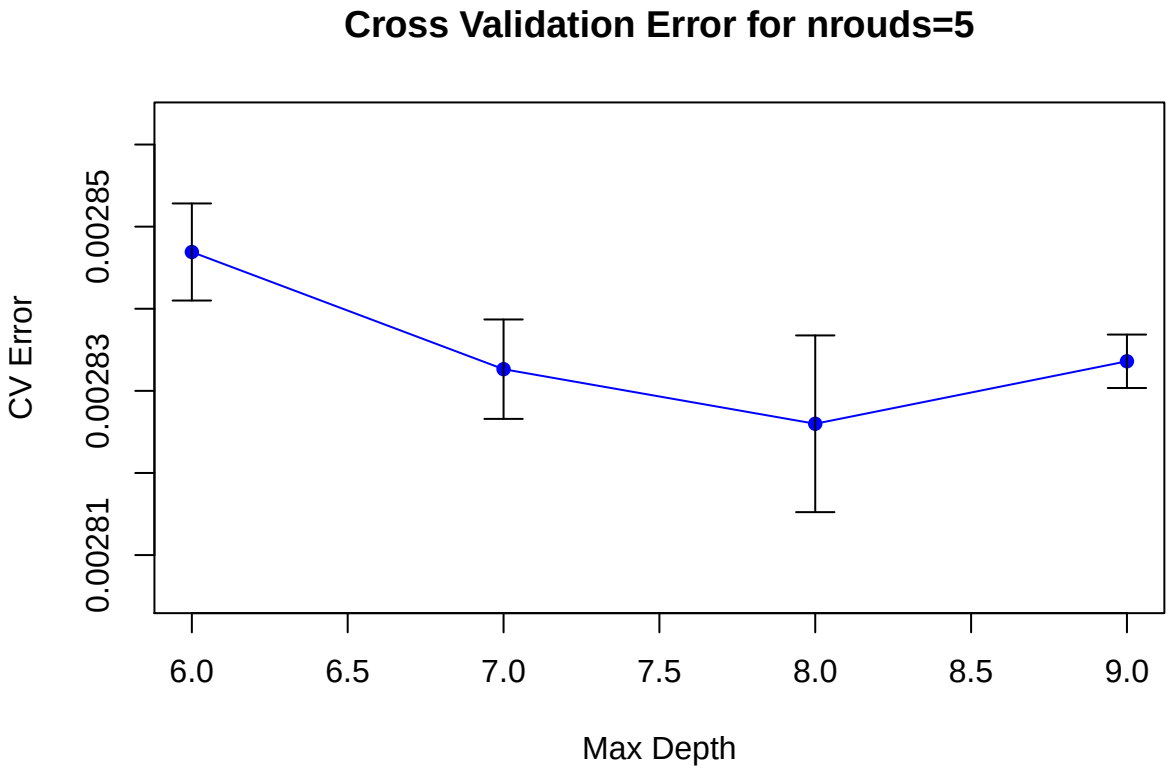
Visualize cross-validation results.

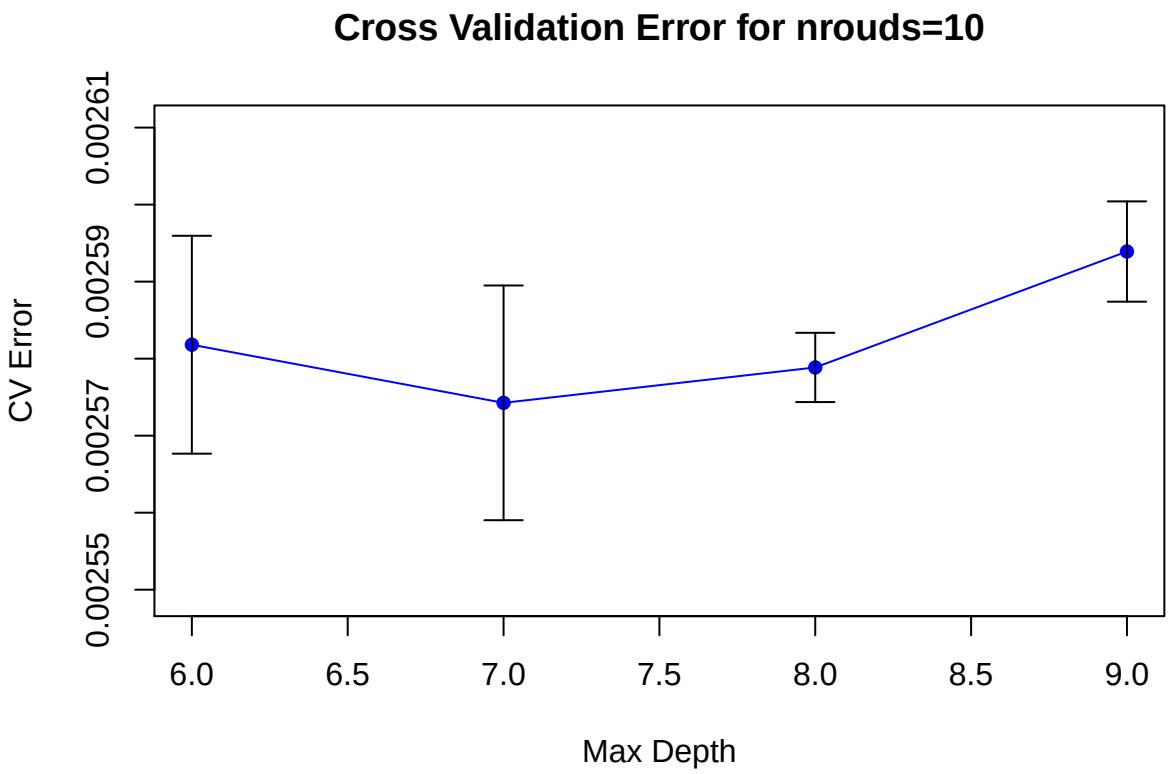
```
if(run.cv){
  load("../output/err_cv.RData")
  ind1<- c(1,4,7,10)
  ind2<- c(2,5,8,11)
  ind3<- c(3,6,9,12)
  plot(model_values[1, ind1], err_cv[ind1,1], xlab="Max Depth", ylab="CV Error",
       main="Cross Validation Error for nrouds=2", type="n",
       ylim=c(min(err_cv[ind1,1]-err_cv[ind1,2]-0.00001), max(err_cv[ind1,1]+err_cv[ind1,2]+0.00001)))
  points(model_values[1, ind1], err_cv[ind1,1], col="blue", pch=16)
  lines(model_values[1, ind1], err_cv[ind1,1], col="blue")
  arrows(model_values[1, ind1], err_cv[ind1,1]-err_cv[ind1,2], model_values[1, ind1], err_cv[ind1,1]+er
         length=0.1, angle=90, code=3)

  plot(model_values[1, ind2], err_cv[ind2,1], xlab="Max Depth", ylab="CV Error",
       main="Cross Validation Error for nrouds=5", type="n",
       ylim=c(min(err_cv[ind2,1]-err_cv[ind2,2]-0.00001), max(err_cv[ind2,1]+err_cv[ind2,2]+0.00001)))
  points(model_values[1, ind2], err_cv[ind2,1], col="blue", pch=16)
  lines(model_values[1, ind2], err_cv[ind2,1], col="blue")
  arrows(model_values[1, ind2], err_cv[ind2,1]-err_cv[ind2,2], model_values[1, ind2], err_cv[ind2,1]+er
         length=0.1, angle=90, code=3)

  plot(model_values[1, ind3], err_cv[ind3,1], xlab="Max Depth", ylab="CV Error",
       main="Cross Validation Error for nrouds=10", type="n",
       ylim=c(min(err_cv[ind3,1]-err_cv[ind3,2]-0.00001), max(err_cv[ind3,1]+err_cv[ind3,2]+0.00001)))
  points(model_values[1, ind3], err_cv[ind3,1], col="blue", pch=16)
  lines(model_values[1, ind3], err_cv[ind3,1], col="blue")
  arrows(model_values[1, ind3], err_cv[ind3,1]-err_cv[ind3,2], model_values[1, ind3], err_cv[ind3,1]+er
         length=0.1, angle=90, code=3)
}
```


Cross Validation Error for nrouds=2
CV Error
0.01838
0.01835
0.01832
6.0
6.5
7.0
7.5
8.0
8.5
9.0
Max Depth


Cross Validation Error for nrouds=5
CV Error
0.00281
0.00283
0.00285
6.0
6.5
7.0
7.5
8.0
8.5
9.0
Max Depth



- Choose the "best"" parameter value

```
model_best=model_values[1]
if(run.cv){
  model_best <- model_values[, which.min(err_cv[,1])]
}

par_best <- list(depth=model_best[1], nr=model_best[2])
par_best
```

```
## $depth
## [1] 7
##
## $nr
## [1] 10
```

- Train the model with the entire training set using the selected model (model parameter) via cross-validation.

```
tm_train=NA
tm_train <- system.time(fit_train <- train(feat_train, label_train, par_best))
save(fit_train, file="../output/fit_train.RData")
```

Step 5: Super-resolution for test images

Feed the final training model with the completely holdout testing data. + `superResolution.R` + Input: a path that points to the folder of low-resolution test images. + Input: a path that points to the folder (empty)

of high-resolution test images. + Input: an R object that contains tuned predictors. + Output: construct high-resolution versions for each low-resolution test image.

```
source("../lib/superResolution.R")
test_dir <- "../data/test_set/" # This will be modified for different data sets.
test_LR_dir <- paste(test_dir, "LR/", sep="")
test_HR_dir <- paste(test_dir, "HR/", sep="")

tm_test=NA
if(run.test){
  load(file="../output/fit_train.RData")
  tm_test <- system.time(superResolution(test_LR_dir, test_HR_dir, fit_train))
}
```

Error

```
#MSE
e<- err_cv[which.min(err_cv[,1]), 1]
e
```

```
## [1] 0.002574261
```

```
#PSNR
20*log10(1)-10*log10(e)
```

```
## [1] 25.89347
```

Summarize Running Time

Prediction performance matters, so does the running times for constructing features and for training the model, especially when the computation resource is limited.

```
cat("Time for constructing training features=", tm_feature_train[1], "s \n")
```

```
## Time for constructing training features= 76.22 s
```

```
#cat("Time for constructing testing features=", tm_feature_test[1], "s \n")
cat("Time for training model=", tm_train[1], "s \n")
```

```
## Time for training model= 537.67 s
```

```
cat("Time for super-resolution=", tm_test[1], "s \n")
```

```
## Time for super-resolution= 988.44 s
```