house-price-prediction-part2

March 19, 2019

In [95]:
```
import pandas as pd
import numpy as np
%matplotlib inline
import matplotlib.pyplot as plt
import seaborn as sns
import warnings
warnings.filterwarnings('ignore')
from scipy import stats
from scipy.stats import norm, skew
from scipy.special import boxcox1p
#inv - inv_boxcox1p(y, 2.5)
from sklearn.model_selection import KFold, cross_val_score, train_test_split
from sklearn.preprocessing import StandardScaler, MinMaxScaler
from sklearn.linear_model import LinearRegression, Ridge, RidgeCV, Lasso, LassoCV, Ela
from sklearn.kernel_ridge import KernelRidge
from sklearn.base import BaseEstimator, TransformerMixin, RegressorMixin, clone
from sklearn.metrics import mean_squared_error
from sklearn.ensemble import RandomForestRegressor,  GradientBoostingRegressor


import xgboost as xgb
import lightgbm as lgb
import tensorflow as tf
```

In [96]:
```
df = pd.read_csv('housing.data', sep='\s+', header=None, names=['CRIM', 'ZN', 'INDUS'
```

In [97]:
```
df.head()
```

Out[97]:
```
      CRIM    ZN  INDUS  CHAS    NOX     RM   AGE     DIS  RAD    TAX  \
0  0.00632  18.0   2.31     0  0.538  6.575  65.2  4.0900    1  296.0
1  0.02731   0.0   7.07     0  0.469  6.421  78.9  4.9671    2  242.0
2  0.02729   0.0   7.07     0  0.469  7.185  61.1  4.9671    2  242.0
3  0.03237   0.0   2.18     0  0.458  6.998  45.8  6.0622    3  222.0
4  0.06905   0.0   2.18     0  0.458  7.147  54.2  6.0622    3  222.0

   PTRATIO       B  LSTAT  MEDV
0     15.3  396.90   4.98  24.0
1     17.8  396.90   9.14  21.6
```

```
2      17.8   392.83   4.03   34.7
3      18.7   394.63   2.94   33.4
4      18.7   396.90   5.33   36.2
```

1 Part 2. Modelling & Evaluation

-

1.1 preprocessing

We will preprocess the data just like part1

```
In [98]: df['MEDV'] = np.log1p(df['MEDV'])

In [99]: df['MEDV'].describe()

Out[99]: count    506.000000
         mean       3.085437
         std        0.386966
         min        1.791759
         25%        2.891757
         50%        3.100092
         75%        3.258097
         max        3.931826
         Name: MEDV, dtype: float64

In [100]: for i in df.columns[:-1]:
              print(i)
              print(df[i].skew(), df[i].kurt())
              if i != 'CHAS' and (abs(df[i].skew()) > 0.75):
                  df[i] = boxcox1p(df[i], 0.35)
                  #df[i] = np.log1p(df[i])

                  print(df[i].skew(), df[i].kurt())

              print('--------------------------')

CRIM
5.223148798243851 37.13050912952203
1.9740843132332258 4.308580743930477
--------------------------
ZN
2.2256663227354307 4.031510083739155
1.4314701905207694 0.537160832923989
--------------------------
INDUS
0.29502156787351164 -1.2335396011495188
--------------------------
```

```
CHAS
3.405904172058746 9.638263777819526
--------------------------
NOX
0.7293079225348787 -0.06466713336542629
--------------------------
RM
0.40361213328874385 1.8915003664993404
--------------------------
AGE
-0.5989626398812962 -0.9677155941626912
--------------------------
DIS
1.0117805793009007 0.4879411222443908
0.5524972546768439 -0.6085593626946499
--------------------------
RAD
1.0048146482182057 -0.8672319936034931
0.7928936001671438 -0.9257488088889918
--------------------------
TAX
0.669955941795016 -1.1424079924768082
--------------------------
PTRATIO
-0.8023249268537809 -0.28509138330538875
-0.9304346714775735 0.014518330337779162
--------------------------
B
-2.8903737121414492 7.226817549260753
-3.5617983031004257 12.266124951669918
--------------------------
LSTAT
0.9064600935915367 0.49323951739272776
0.19637250446963392 -0.5776346879624561
--------------------------
```

-

1.2 Split data into two parts and apply MinMax Scaler to the data

we are going to split the data into train set and test set with 8:2 ratio. Moreover, because test data has to be treated as unseen data, we should apply MinMaxScaler to the train set first and then use it to the test set.

In [101]:
```
num_features = ['CRIM', 'ZN', 'INDUS','NOX','RM','AGE','DIS','RAD','TAX','PTRATIO','I
```

In [102]:
```
data_num = df[num_features]
```

Applied one-hot encoding to a categorical feature.

```
In [103]: data_catg = pd.get_dummies(df['CHAS'], prefix='CHAS')
```

```
In [104]: y = df['MEDV']
```

```
In [105]: data = pd.concat([data_num, data_catg], axis=1)
```

```
In [106]: X_train, X_test, y_train, y_test = train_test_split(data, y, test_size = 0.2, random_
          print("X_train : " + str(X_train.shape))
          print("X_test : " + str(X_test.shape))
          print("y_train : " + str(y_train.shape))
          print("y_test : " + str(y_test.shape))
```

```
X_train : (404, 14)
X_test : (102, 14)
y_train : (404,)
y_test : (102,)
```

```
In [107]: X_train.head()
```

```
Out[107]:          CRIM       ZN  INDUS    NOX     RM   AGE       DIS       RAD    TAX  \
          288  0.045232  8.64704   5.32  0.405  6.315  45.6  3.139718  2.788537  293.0
          72   0.089040  0.00000  10.81  0.413  6.065   7.8  2.580296  2.161329  305.0
          471  2.174788  0.00000  18.10  0.532  6.229  90.7  1.824307  5.957627  666.0
          176  0.068677  0.00000   4.05  0.510  6.020  47.2  2.000209  2.492009  296.0
          320  0.159229  0.00000   7.38  0.493  6.426  52.3  2.344869  2.492009  287.0

                PTRATIO          B     LSTAT  CHAS_0  CHAS_1
          288  4.938670  20.362356  3.210310       1       0
          72   5.323830  20.239411  2.649902       1       0
          471  5.463359  20.330248  4.315162       1       0
          176  4.938670  20.287173  3.779247       1       0
          320  5.380169  20.362356  3.110005       1       0
```

```
In [108]: #stdSc = StandardScaler()
          #X_train.loc[:, num_features] = stdSc.fit_transform(X_train.loc[:, num_features])
          #X_test.loc[:, num_features] = stdSc.transform(X_test.loc[:, num_features])
```

```
In [109]: minmaxSc = MinMaxScaler()
          X_train.loc[:, num_features] = minmaxSc.fit_transform(X_train.loc[:, num_features])
          X_test.loc[:, num_features] = minmaxSc.transform(X_test.loc[:, num_features])
```

```
In [110]: X_train = X_train.values
          X_test = X_test.values
          y_train = y_train.values
          y_test =y_test.values
          print("X_train : " + str(X_train.shape))
          print("X_test : " + str(X_test.shape))
          print("y_train : " + str(y_train.shape))
          print("y_test : " + str(y_test.shape))
```

```
X_train : (404, 14)
X_test : (102, 14)
y_train : (404,)
y_test : (102,)
```

-

1.3 Models

1.3.1 1. Linear Regression

Linear Regression performance result would be used as the basic measure when it comes to evaluation including variance and bias

```
In [111]: lr = LinearRegression()
```

1.3.2 2. Ridge Regression (regularization model)

If there is high variance, this model might decrease the variance. Did some grid search for a hyperparameter

```
In [112]: ridge = RidgeCV(cv=5, alphas = [0.01, 0.03, 0.06, 0.1, 0.3, 0.6, 1, 3, 6, 10, 30, 60
          ridge.fit(X_train, y_train)
          alpha = ridge.alpha_
          print("Best alpha :", alpha)

          print("Try again for more precision with alphas centered around " + str(alpha))
          ridge = RidgeCV(alphas = [alpha * .6, alpha * .65, alpha * .7, alpha * .75, alpha *
                                    alpha * .9, alpha * .95, alpha, alpha * 1.05, alpha * 1.1,
                                    alpha * 1.25, alpha * 1.3, alpha * 1.35, alpha * 1.4],
                          cv = 10)
          ridge.fit(X_train, y_train)
          alpha = ridge.alpha_
          print("Best alpha :", alpha)
```

```
Best alpha : 0.1
Try again for more precision with alphas centered around 0.1
Best alpha : 0.13999999999999999
```

```
In [113]: ridge = Ridge(alpha=alpha)
```

1.3.3 3. Lasso Regression (another regularization model)

```
In [114]: lasso = LassoCV(alphas = [0.0001, 0.0003, 0.0006, 0.001, 0.003, 0.006, 0.01, 0.03, 0
                                    0.3, 0.6, 1],
                          max_iter = 50000, cv = 10)
```

```
        lasso.fit(X_train, y_train)
        alpha = lasso.alpha_
        print("Best alpha :", alpha)

        print("Try again for more precision with alphas centered around " + str(alpha))
        lasso = LassoCV(alphas = [alpha * .6, alpha * .65, alpha * .7, alpha * .75, alpha *
                                  alpha * .85, alpha * .9, alpha * .95, alpha, alpha * 1.05,
                                  alpha * 1.1, alpha * 1.15, alpha * 1.25, alpha * 1.3, alpha
                                  alpha * 1.4],
                        max_iter = 50000, cv = 10)
        lasso.fit(X_train, y_train)
        alpha = lasso.alpha_
        print("Best alpha :", alpha)
```

```
Best alpha : 0.0001
Try again for more precision with alphas centered around 0.0001
Best alpha : 6e-05
```

```
In [115]: lasso = Lasso(alpha=alpha)
```

1.3.4 4. ElasticNet (Ridge + Lasso)

```
In [116]: elasticNet = ElasticNetCV(l1_ratio = [0.1, 0.3, 0.5, 0.6, 0.7, 0.8, 0.85, 0.9, 0.95,
                                    alphas = [0.0001, 0.0003, 0.0006, 0.001, 0.003, 0.006,
                                              0.01, 0.03, 0.06, 0.1, 0.3, 0.6, 1, 3, 6],
                                    max_iter = 50000, cv = 10)
        elasticNet.fit(X_train, y_train)
        alpha = elasticNet.alpha_
        ratio = elasticNet.l1_ratio_
        print("Best l1_ratio :", ratio)
        print("Best alpha :", alpha )

        print("Try again for more precision with l1_ratio centered around " + str(ratio))
        elasticNet = ElasticNetCV(l1_ratio = [ratio * .85, ratio * .9, ratio * .95, ratio, ra
                                  alphas = [0.0001, 0.0003, 0.0006, 0.001, 0.003, 0.006, 0.0
                                  max_iter = 50000, cv = 10)
        elasticNet.fit(X_train, y_train)
        if (elasticNet.l1_ratio_ > 1):
            elasticNet.l1_ratio_ = 1
        alpha = elasticNet.alpha_
        ratio = elasticNet.l1_ratio_
        print("Best l1_ratio :", ratio)
        print("Best alpha :", alpha )

        print("Now try again for more precision on alpha, with l1_ratio fixed at " + str(rati
              " and alpha centered around " + str(alpha))
        elasticNet = ElasticNetCV(l1_ratio = ratio,
```

```
                                    alphas = [alpha * .6, alpha * .65, alpha * .7, alpha * .75
                                              alpha * .95, alpha, alpha * 1.05, alpha * 1.1, al
                                              alpha * 1.35, alpha * 1.4],
                                    max_iter = 50000, cv = 10)
          elasticNet.fit(X_train, y_train)
          if (elasticNet.l1_ratio_ > 1):
              elasticNet.l1_ratio_ = 1
          alpha = elasticNet.alpha_
          ratio = elasticNet.l1_ratio_
          print("Best l1_ratio :", ratio)
          print("Best alpha :", alpha )
```

```
Best l1_ratio : 0.1
Best alpha : 0.0003
Try again for more precision with l1_ratio centered around 0.1
Best l1_ratio : 0.085
Best alpha : 0.0003
Now try again for more precision on alpha, with l1_ratio fixed at 0.085 and alpha centered arou
Best l1_ratio : 0.085
Best alpha : 0.000225
```

```
In [117]: elasticNet = ElasticNet(alpha=alpha, l1_ratio=ratio)
```

1.3.5 5. Kernel Ridge Regression (l2-norm + kernel trick)

```
In [118]: KRR = KernelRidge(alpha=0.1399, kernel='polynomial', degree=7, coef0=3.5)
```

1.3.6 6. Random Forest Regression (Bagging)

```
In [119]: randomForest = RandomForestRegressor(n_estimators=600, oob_score=True, min_samples_le
```

1.3.7 7. Gradient Boosting Regression (Boosting)

```
In [120]: gboost = GradientBoostingRegressor(n_estimators=3000, learning_rate=0.1,
                                             max_depth=4, max_features='sqrt',
                                             min_samples_leaf=15, min_samples_split=10,
                                             loss='huber', random_state =5)
```

1.3.8 8. XGBoost (Boosting)

```
In [121]: xgboost = xgb.XGBRegressor(colsample_bytree=0.6, gamma=0.0,
                                     learning_rate=0.1, max_depth=4,
                                     min_child_weight=2, n_estimators=2000,
                                     reg_alpha=0.5, reg_lambda=0.8,
                                     subsample=0.5, silent=1,
                                     random_state =7, nthread = -1)
```

1.3.9 9. LightGBM (Boosting)

```
In [122]: light_gbm = lgb.LGBMRegressor(objective='regression',num_leaves=5,
                                        learning_rate=0.05, n_estimators=720,
                                        max_bin = 55, bagging_fraction = 0.8,
                                        bagging_freq = 5, feature_fraction = 0.25,
                                        feature_fraction_seed=9, bagging_seed=9,
                                        min_data_in_leaf =7, min_sum_hessian_in_leaf = 11)
```

1.3.10 10. Simple Stack Model (Average)

```
In [123]: class AveragingModels(BaseEstimator, RegressorMixin, TransformerMixin):
              def __init__(self, models):
                  self.models = models

              # we define clones of the original models to fit the data in
              def fit(self, X, y):
                  self.models_ = [clone(x) for x in self.models]

                  # Train cloned base models
                  for model in self.models_:
                      model.fit(X, y)

                  return self

              #Now we do the predictions for cloned models and average them
              def predict(self, X):
                  predictions = np.column_stack([
                      model.predict(X) for model in self.models_
                  ])
                  return np.mean(predictions, axis=1)
```

1.3.11 11. Stack model with a Meta-model

```
In [124]: class StackingAveragedModels(BaseEstimator, RegressorMixin, TransformerMixin):
              def __init__(self, base_models, meta_model, n_folds=5):
                  self.base_models = base_models
                  self.meta_model = meta_model
                  self.n_folds = n_folds

              # We again fit the data on clones of the original models
              def fit(self, X_train, y_train):
                  #make dummy list
                  self.base_models_ = [list() for x in range(len(self.base_models))]
                  #deep copy
                  self.meta_model_ = clone(self.meta_model)
                  #k-fold spilt
                  kfold = KFold(n_splits=self.n_folds, shuffle=True, random_state=101)
```

```
                # Train cloned base models then create out-of-fold predictions
                # that are needed to train the cloned meta-model

                # (the number of house prices predicted), (the number of level 0 models)
                out_of_fold_predictions = np.zeros((X_train.shape[0], len(self.base_models))
                for i, model in enumerate(self.base_models):
                    for train_index, holdout_index in kfold.split(X_train, y_train):
                        instance = clone(model)
                        self.base_models_[i].append(instance)
                        instance.fit(X_train[train_index], y_train[train_index])
                        y_pred = instance.predict(X_train[holdout_index])
                        out_of_fold_predictions[holdout_index, i] = y_pred

                # Now train the cloned  meta-model using the out-of-fold predictions as new 
                self.meta_model_.fit(out_of_fold_predictions, y_train)
                return self

            #Do the predictions of all base models on the test data and use the averaged pre
            #meta-features for the final prediction which is done by the meta-model
            def predict(self, X_test):
                meta_features = np.column_stack([
                    np.column_stack([model.predict(X_test) for model in base_models]).mean(a
                    for base_models in self.base_models_ ])
                return self.meta_model_.predict(meta_features)
```

1.3.12 12. Deep Neural Network

```
In [186]: feat_cols = [tf.feature_column.numeric_column('x', shape=np.array(X_train).shape[1:]
          input_func = tf.estimator.inputs.numpy_input_fn({'x':X_train}, y_train, batch_size=1
          train_input_func = tf.estimator.inputs.numpy_input_fn({'x':X_train}, y_train, batch_
          train_input_func = tf.estimator.inputs.numpy_input_fn({'x':X_train}, y_train, batch_
          eval_input_func = tf.estimator.inputs.numpy_input_fn({'x': X_test}, y_test, batch_si
          dnn_model = tf.estimator.DNNRegressor(hidden_units=[256, 512, 256, 64],
                                                  feature_columns=feat_cols,
                                                  dropout=0.1,
                                                  activation_fn=tf.nn.relu,
                                                  optimizer=tf.train.AdamOptimizer(learning_rate
                                                  batch_norm=False)
```

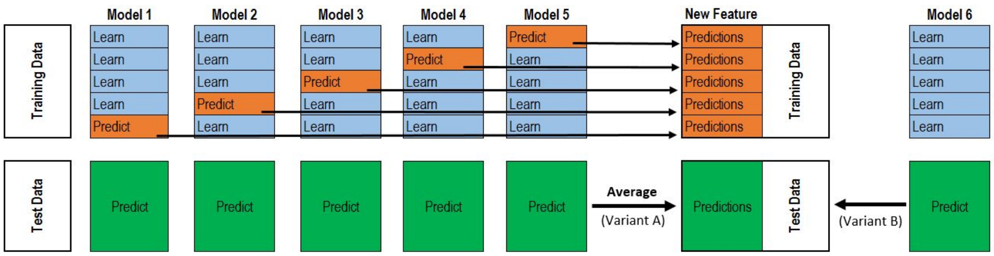
```
INFO:tensorflow:Using default config.
WARNING:tensorflow:Using temporary folder as model directory: /tmp/tmpbzhhoamp
INFO:tensorflow:Using config: {'_model_dir': '/tmp/tmpbzhhoamp', '_tf_random_seed': None, '_sa
graph_options {
  rewrite_options {
    meta_optimizer_iterations: ONE
  }
}
```

```
, '_keep_checkpoint_max': 5, '_keep_checkpoint_every_n_hours': 10000, '_log_step_count_steps':
```

1.4 Train and K-Fold Cross Validation RMSE(root mean square error)

K-Fold Cross Validation RMSE(root mean square error) would be used as a train error, but for convenience, k-fold cross validation is not used when we calculate the Deep Neural Network train error.

```
In [128]: def rmse_5cv(model):
              kf = KFold(5, shuffle=True, random_state=101)
              rmse= np.sqrt(-cross_val_score(model, X_train, y_train, scoring="neg_mean_squared
              return(rmse)

In [174]: #for bar plot
          d = {'models': ['lr', 'ridge', 'lasso', 'elasticNet','KRR','randomForest','gboost','
               'test': [0.,0.,0.,0.,0.,0.,0.,0.,0.,0.,0.,0.] }
          df_rmse =pd.DataFrame(data=d)

In [175]: score = rmse_5cv(lr)
          df_rmse['cv'][0] = score.mean()

In [176]: score = rmse_5cv(ridge)
          df_rmse['cv'][1] = score.mean()

In [177]: score = rmse_5cv(lasso)
          df_rmse['cv'][2] = score.mean()

In [178]: score = rmse_5cv(elasticNet)
          df_rmse['cv'][3] = score.mean()

In [179]: score = rmse_5cv(KRR)
          df_rmse['cv'][4] = score.mean()

In [180]: score = rmse_5cv(randomForest)
          df_rmse['cv'][5] = score.mean()

In [181]: score = rmse_5cv(gboost)
          df_rmse['cv'][6] = score.mean()

In [182]: score = rmse_5cv(xgboost)
          df_rmse['cv'][7] = score.mean()

In [183]: score = rmse_5cv(light_gbm)
          df_rmse['cv'][8] = score.mean()

In [184]: averaged_models = AveragingModels(models = (elasticNet, gboost, KRR, xgboost))
          score = rmse_5cv(averaged_models)
          df_rmse['cv'][9] = score.mean()
```



stack

- here's stack meta model process

1. Split the total training set into two disjoint sets (here train and .holdout)
2. Train several base models on the first part (train)
3. Test these base models on the second part (holdout)
4. Use the predictions from 3) (called out-of-folds predictions) as the inputs, and the correct responses (target variable) as the outputs to train a higher level learner called meta-model.

In [185]:
```
stacked_averaged_models = StackingAveragedModels(base_models = (elasticNet, ridge, gl
                                                 meta_model = lasso)
score = rmse_5cv(stacked_averaged_models)
df_rmse['cv'][10] = score.mean()
```

In [189]:
```
dnn_model.train(input_fn=input_func, steps=40000)
```

```
INFO:tensorflow:Calling model_fn.
INFO:tensorflow:Done calling model_fn.
INFO:tensorflow:Create CheckpointSaverHook.
INFO:tensorflow:Graph was finalized.
INFO:tensorflow:Running local_init_op.
INFO:tensorflow:Done running local_init_op.
INFO:tensorflow:Saving checkpoints for 0 into /tmp/tmpbzhhoamp/model.ckpt.
INFO:tensorflow:loss = 178.39738, step = 1
INFO:tensorflow:global_step/sec: 604.347
INFO:tensorflow:loss = 1.7649081, step = 101 (0.166 sec)
INFO:tensorflow:global_step/sec: 845.634
INFO:tensorflow:loss = 4.5736995, step = 201 (0.118 sec)
INFO:tensorflow:global_step/sec: 847.326
INFO:tensorflow:loss = 2.5050454, step = 301 (0.118 sec)
INFO:tensorflow:global_step/sec: 844.965
INFO:tensorflow:loss = 2.197303, step = 401 (0.118 sec)
INFO:tensorflow:global_step/sec: 847.66
INFO:tensorflow:loss = 1.3260994, step = 501 (0.118 sec)
INFO:tensorflow:global_step/sec: 848.532
INFO:tensorflow:loss = 0.6739668, step = 601 (0.118 sec)
INFO:tensorflow:global_step/sec: 846.932
```

```
INFO:tensorflow:loss = 2.6951027, step = 701 (0.118 sec)
INFO:tensorflow:global_step/sec: 845.549
INFO:tensorflow:loss = 0.9293392, step = 801 (0.118 sec)
INFO:tensorflow:global_step/sec: 847.387
INFO:tensorflow:loss = 1.9698118, step = 901 (0.118 sec)
INFO:tensorflow:global_step/sec: 766.132
INFO:tensorflow:loss = 1.092966, step = 1001 (0.131 sec)
INFO:tensorflow:global_step/sec: 831.71
INFO:tensorflow:loss = 1.6190054, step = 1101 (0.120 sec)
INFO:tensorflow:global_step/sec: 847.528
INFO:tensorflow:loss = 3.7056236, step = 1201 (0.118 sec)
INFO:tensorflow:global_step/sec: 850.444
INFO:tensorflow:loss = 1.1744306, step = 1301 (0.118 sec)
INFO:tensorflow:global_step/sec: 845.955
INFO:tensorflow:loss = 0.84077585, step = 1401 (0.118 sec)
INFO:tensorflow:global_step/sec: 849.486
INFO:tensorflow:loss = 2.3181264, step = 1501 (0.118 sec)
INFO:tensorflow:global_step/sec: 848.531
INFO:tensorflow:loss = 1.2092261, step = 1601 (0.118 sec)
INFO:tensorflow:global_step/sec: 848.369
INFO:tensorflow:loss = 2.200201, step = 1701 (0.118 sec)
INFO:tensorflow:global_step/sec: 849.965
INFO:tensorflow:loss = 1.8286071, step = 1801 (0.118 sec)
INFO:tensorflow:global_step/sec: 848.282
INFO:tensorflow:loss = 0.77931494, step = 1901 (0.118 sec)
INFO:tensorflow:global_step/sec: 846.223
INFO:tensorflow:loss = 1.059664, step = 2001 (0.118 sec)
INFO:tensorflow:global_step/sec: 851.219
INFO:tensorflow:loss = 1.4233212, step = 2101 (0.118 sec)
INFO:tensorflow:global_step/sec: 848.783
INFO:tensorflow:loss = 1.7852312, step = 2201 (0.118 sec)
INFO:tensorflow:global_step/sec: 844.461
INFO:tensorflow:loss = 0.9636028, step = 2301 (0.118 sec)
INFO:tensorflow:global_step/sec: 850.673
INFO:tensorflow:loss = 1.1112953, step = 2401 (0.118 sec)
INFO:tensorflow:global_step/sec: 851.214
INFO:tensorflow:loss = 1.5248646, step = 2501 (0.117 sec)
INFO:tensorflow:global_step/sec: 852.919
INFO:tensorflow:loss = 0.87089247, step = 2601 (0.117 sec)
INFO:tensorflow:global_step/sec: 849.793
INFO:tensorflow:loss = 1.5765687, step = 2701 (0.118 sec)
INFO:tensorflow:global_step/sec: 849.266
INFO:tensorflow:loss = 0.7262667, step = 2801 (0.118 sec)
INFO:tensorflow:global_step/sec: 850.77
INFO:tensorflow:loss = 1.1270647, step = 2901 (0.118 sec)
INFO:tensorflow:global_step/sec: 848.726
INFO:tensorflow:loss = 0.9464989, step = 3001 (0.118 sec)
INFO:tensorflow:global_step/sec: 850.898
```

```
INFO:tensorflow:loss = 0.9625592, step = 3101 (0.117 sec)
INFO:tensorflow:global_step/sec: 849.324
INFO:tensorflow:loss = 1.3165689, step = 3201 (0.118 sec)
INFO:tensorflow:global_step/sec: 848.507
INFO:tensorflow:loss = 1.869753, step = 3301 (0.118 sec)
INFO:tensorflow:global_step/sec: 846.558
INFO:tensorflow:loss = 1.4230223, step = 3401 (0.118 sec)
INFO:tensorflow:global_step/sec: 851.139
INFO:tensorflow:loss = 0.9866274, step = 3501 (0.118 sec)
INFO:tensorflow:global_step/sec: 849.467
INFO:tensorflow:loss = 0.8958998, step = 3601 (0.118 sec)
INFO:tensorflow:global_step/sec: 850.082
INFO:tensorflow:loss = 1.2378082, step = 3701 (0.118 sec)
INFO:tensorflow:global_step/sec: 847.663
INFO:tensorflow:loss = 0.6358701, step = 3801 (0.118 sec)
INFO:tensorflow:global_step/sec: 846.18
INFO:tensorflow:loss = 0.845125, step = 3901 (0.118 sec)
INFO:tensorflow:global_step/sec: 850.144
INFO:tensorflow:loss = 1.2765646, step = 4001 (0.118 sec)
INFO:tensorflow:global_step/sec: 846.105
INFO:tensorflow:loss = 1.2199162, step = 4101 (0.118 sec)
INFO:tensorflow:global_step/sec: 849.204
INFO:tensorflow:loss = 1.0041978, step = 4201 (0.118 sec)
INFO:tensorflow:global_step/sec: 849.424
INFO:tensorflow:loss = 1.0379124, step = 4301 (0.118 sec)
INFO:tensorflow:global_step/sec: 846.65
INFO:tensorflow:loss = 1.2486844, step = 4401 (0.118 sec)
INFO:tensorflow:global_step/sec: 848.666
INFO:tensorflow:loss = 1.2312347, step = 4501 (0.118 sec)
INFO:tensorflow:global_step/sec: 847.738
INFO:tensorflow:loss = 1.8371366, step = 4601 (0.118 sec)
INFO:tensorflow:global_step/sec: 844.694
INFO:tensorflow:loss = 2.7626457, step = 4701 (0.118 sec)
INFO:tensorflow:global_step/sec: 836.509
INFO:tensorflow:loss = 1.332088, step = 4801 (0.120 sec)
INFO:tensorflow:global_step/sec: 849.448
INFO:tensorflow:loss = 1.3692257, step = 4901 (0.118 sec)
INFO:tensorflow:global_step/sec: 849.705
INFO:tensorflow:loss = 0.99574375, step = 5001 (0.118 sec)
INFO:tensorflow:global_step/sec: 849.185
INFO:tensorflow:loss = 1.2610366, step = 5101 (0.118 sec)
INFO:tensorflow:global_step/sec: 847.848
INFO:tensorflow:loss = 0.94208086, step = 5201 (0.118 sec)
INFO:tensorflow:global_step/sec: 846.17
INFO:tensorflow:loss = 1.4081312, step = 5301 (0.118 sec)
INFO:tensorflow:global_step/sec: 851.881
INFO:tensorflow:loss = 0.4880274, step = 5401 (0.117 sec)
INFO:tensorflow:global_step/sec: 847.534
```

```
INFO:tensorflow:loss = 0.98114914, step = 5501 (0.118 sec)
INFO:tensorflow:global_step/sec: 850.173
INFO:tensorflow:loss = 1.2964604, step = 5601 (0.118 sec)
INFO:tensorflow:global_step/sec: 852.291
INFO:tensorflow:loss = 1.259505, step = 5701 (0.117 sec)
INFO:tensorflow:global_step/sec: 848.914
INFO:tensorflow:loss = 1.3695455, step = 5801 (0.118 sec)
INFO:tensorflow:global_step/sec: 846.987
INFO:tensorflow:loss = 0.6957019, step = 5901 (0.118 sec)
INFO:tensorflow:global_step/sec: 847.048
INFO:tensorflow:loss = 0.8268024, step = 6001 (0.118 sec)
INFO:tensorflow:global_step/sec: 849.096
INFO:tensorflow:loss = 1.128581, step = 6101 (0.118 sec)
INFO:tensorflow:global_step/sec: 850.142
INFO:tensorflow:loss = 0.98131424, step = 6201 (0.118 sec)
INFO:tensorflow:global_step/sec: 852.92
INFO:tensorflow:loss = 1.2075214, step = 6301 (0.117 sec)
INFO:tensorflow:global_step/sec: 848.781
INFO:tensorflow:loss = 1.1286181, step = 6401 (0.118 sec)
INFO:tensorflow:global_step/sec: 847.469
INFO:tensorflow:loss = 0.6309943, step = 6501 (0.118 sec)
INFO:tensorflow:global_step/sec: 854.258
INFO:tensorflow:loss = 0.8355088, step = 6601 (0.117 sec)
INFO:tensorflow:global_step/sec: 847.833
INFO:tensorflow:loss = 1.131295, step = 6701 (0.118 sec)
INFO:tensorflow:global_step/sec: 848.881
INFO:tensorflow:loss = 0.9801073, step = 6801 (0.118 sec)
INFO:tensorflow:global_step/sec: 845.895
INFO:tensorflow:loss = 1.4275553, step = 6901 (0.118 sec)
INFO:tensorflow:global_step/sec: 847.1
INFO:tensorflow:loss = 0.78274137, step = 7001 (0.118 sec)
INFO:tensorflow:global_step/sec: 847.788
INFO:tensorflow:loss = 0.9589175, step = 7101 (0.118 sec)
INFO:tensorflow:global_step/sec: 844.735
INFO:tensorflow:loss = 1.6194556, step = 7201 (0.118 sec)
INFO:tensorflow:global_step/sec: 846.677
INFO:tensorflow:loss = 0.8164135, step = 7301 (0.118 sec)
INFO:tensorflow:global_step/sec: 843.879
INFO:tensorflow:loss = 0.73004663, step = 7401 (0.119 sec)
INFO:tensorflow:global_step/sec: 846.305
INFO:tensorflow:loss = 1.5592957, step = 7501 (0.119 sec)
INFO:tensorflow:global_step/sec: 846.84
INFO:tensorflow:loss = 1.0835115, step = 7601 (0.117 sec)
INFO:tensorflow:global_step/sec: 850.18
INFO:tensorflow:loss = 1.28877, step = 7701 (0.118 sec)
INFO:tensorflow:global_step/sec: 849.046
INFO:tensorflow:loss = 0.83545834, step = 7801 (0.118 sec)
INFO:tensorflow:global_step/sec: 849.003
```

```
INFO:tensorflow:loss = 0.89720476, step = 7901 (0.118 sec)
INFO:tensorflow:global_step/sec: 846.949
INFO:tensorflow:loss = 0.8604207, step = 8001 (0.118 sec)
INFO:tensorflow:global_step/sec: 849.429
INFO:tensorflow:loss = 0.8246075, step = 8101 (0.118 sec)
INFO:tensorflow:global_step/sec: 848.843
INFO:tensorflow:loss = 0.831802, step = 8201 (0.118 sec)
INFO:tensorflow:global_step/sec: 848.821
INFO:tensorflow:loss = 1.7484044, step = 8301 (0.118 sec)
INFO:tensorflow:global_step/sec: 850.113
INFO:tensorflow:loss = 1.1522936, step = 8401 (0.118 sec)
INFO:tensorflow:global_step/sec: 848.546
INFO:tensorflow:loss = 0.98780453, step = 8501 (0.118 sec)
INFO:tensorflow:global_step/sec: 849.159
INFO:tensorflow:loss = 0.69049644, step = 8601 (0.118 sec)
INFO:tensorflow:global_step/sec: 849.522
INFO:tensorflow:loss = 1.5795592, step = 8701 (0.118 sec)
INFO:tensorflow:global_step/sec: 846.725
INFO:tensorflow:loss = 1.061601, step = 8801 (0.118 sec)
INFO:tensorflow:global_step/sec: 848.467
INFO:tensorflow:loss = 1.5389185, step = 8901 (0.118 sec)
INFO:tensorflow:global_step/sec: 845.379
INFO:tensorflow:loss = 1.0821863, step = 9001 (0.118 sec)
INFO:tensorflow:global_step/sec: 837.675
INFO:tensorflow:loss = 1.2973864, step = 9101 (0.119 sec)
INFO:tensorflow:global_step/sec: 849.851
INFO:tensorflow:loss = 0.5642351, step = 9201 (0.118 sec)
INFO:tensorflow:global_step/sec: 848.716
INFO:tensorflow:loss = 0.77311325, step = 9301 (0.118 sec)
INFO:tensorflow:global_step/sec: 847.704
INFO:tensorflow:loss = 1.1211048, step = 9401 (0.118 sec)
INFO:tensorflow:global_step/sec: 850.089
INFO:tensorflow:loss = 1.0082245, step = 9501 (0.118 sec)
INFO:tensorflow:global_step/sec: 853.215
INFO:tensorflow:loss = 1.2696047, step = 9601 (0.117 sec)
INFO:tensorflow:global_step/sec: 851.936
INFO:tensorflow:loss = 1.1553597, step = 9701 (0.117 sec)
INFO:tensorflow:global_step/sec: 848.788
INFO:tensorflow:loss = 2.6899917, step = 9801 (0.118 sec)
INFO:tensorflow:global_step/sec: 849.412
INFO:tensorflow:loss = 1.1758924, step = 9901 (0.118 sec)
INFO:tensorflow:global_step/sec: 848.893
INFO:tensorflow:loss = 1.1154763, step = 10001 (0.118 sec)
INFO:tensorflow:global_step/sec: 849.018
INFO:tensorflow:loss = 0.54155684, step = 10101 (0.118 sec)
INFO:tensorflow:global_step/sec: 850.946
INFO:tensorflow:loss = 0.51641893, step = 10201 (0.118 sec)
INFO:tensorflow:global_step/sec: 846.758
```

```
INFO:tensorflow:loss = 0.5785159, step = 10301 (0.118 sec)
INFO:tensorflow:global_step/sec: 851.191
INFO:tensorflow:loss = 1.3473616, step = 10401 (0.117 sec)
INFO:tensorflow:global_step/sec: 846.228
INFO:tensorflow:loss = 0.97939223, step = 10501 (0.118 sec)
INFO:tensorflow:global_step/sec: 847.997
INFO:tensorflow:loss = 1.3403766, step = 10601 (0.118 sec)
INFO:tensorflow:global_step/sec: 845.602
INFO:tensorflow:loss = 1.3743393, step = 10701 (0.118 sec)
INFO:tensorflow:global_step/sec: 846.201
INFO:tensorflow:loss = 0.82067966, step = 10801 (0.118 sec)
INFO:tensorflow:global_step/sec: 846.951
INFO:tensorflow:loss = 0.85346663, step = 10901 (0.118 sec)
INFO:tensorflow:global_step/sec: 847.206
INFO:tensorflow:loss = 1.8299417, step = 11001 (0.118 sec)
INFO:tensorflow:global_step/sec: 849.736
INFO:tensorflow:loss = 0.74312747, step = 11101 (0.118 sec)
INFO:tensorflow:global_step/sec: 845.986
INFO:tensorflow:loss = 1.3285832, step = 11201 (0.118 sec)
INFO:tensorflow:global_step/sec: 844.761
INFO:tensorflow:loss = 0.766101, step = 11301 (0.118 sec)
INFO:tensorflow:global_step/sec: 849.251
INFO:tensorflow:loss = 0.547143, step = 11401 (0.118 sec)
INFO:tensorflow:global_step/sec: 841.728
INFO:tensorflow:loss = 1.6929853, step = 11501 (0.119 sec)
INFO:tensorflow:global_step/sec: 849.533
INFO:tensorflow:loss = 1.2928057, step = 11601 (0.118 sec)
INFO:tensorflow:global_step/sec: 844.115
INFO:tensorflow:loss = 0.66294944, step = 11701 (0.118 sec)
INFO:tensorflow:global_step/sec: 846.336
INFO:tensorflow:loss = 0.8799038, step = 11801 (0.118 sec)
INFO:tensorflow:global_step/sec: 847.834
INFO:tensorflow:loss = 0.879236, step = 11901 (0.118 sec)
INFO:tensorflow:global_step/sec: 841.981
INFO:tensorflow:loss = 0.8781693, step = 12001 (0.119 sec)
INFO:tensorflow:global_step/sec: 850.258
INFO:tensorflow:loss = 0.5011951, step = 12101 (0.118 sec)
INFO:tensorflow:global_step/sec: 846.67
INFO:tensorflow:loss = 2.0595636, step = 12201 (0.118 sec)
INFO:tensorflow:global_step/sec: 840.286
INFO:tensorflow:loss = 0.98434526, step = 12301 (0.119 sec)
INFO:tensorflow:global_step/sec: 847.305
INFO:tensorflow:loss = 1.683609, step = 12401 (0.118 sec)
INFO:tensorflow:global_step/sec: 847.449
INFO:tensorflow:loss = 1.6180096, step = 12501 (0.118 sec)
INFO:tensorflow:global_step/sec: 848.512
INFO:tensorflow:loss = 0.81690115, step = 12601 (0.118 sec)
INFO:tensorflow:global_step/sec: 847.567
```

```
INFO:tensorflow:loss = 0.9350768, step = 12701 (0.118 sec)
INFO:tensorflow:global_step/sec: 847.665
INFO:tensorflow:loss = 0.6244285, step = 12801 (0.118 sec)
INFO:tensorflow:global_step/sec: 846.522
INFO:tensorflow:loss = 0.63336366, step = 12901 (0.118 sec)
INFO:tensorflow:global_step/sec: 845.935
INFO:tensorflow:loss = 1.2140338, step = 13001 (0.118 sec)
INFO:tensorflow:global_step/sec: 847.463
INFO:tensorflow:loss = 1.0741984, step = 13101 (0.118 sec)
INFO:tensorflow:global_step/sec: 850.316
INFO:tensorflow:loss = 2.115923, step = 13201 (0.118 sec)
INFO:tensorflow:global_step/sec: 851.39
INFO:tensorflow:loss = 0.8327202, step = 13301 (0.118 sec)
INFO:tensorflow:global_step/sec: 833.959
INFO:tensorflow:loss = 0.60375243, step = 13401 (0.120 sec)
INFO:tensorflow:global_step/sec: 850.889
INFO:tensorflow:loss = 0.7136112, step = 13501 (0.118 sec)
INFO:tensorflow:global_step/sec: 850.273
INFO:tensorflow:loss = 1.5555518, step = 13601 (0.118 sec)
INFO:tensorflow:global_step/sec: 847.538
INFO:tensorflow:loss = 0.5499567, step = 13701 (0.118 sec)
INFO:tensorflow:global_step/sec: 851.774
INFO:tensorflow:loss = 1.2771266, step = 13801 (0.117 sec)
INFO:tensorflow:global_step/sec: 849.629
INFO:tensorflow:loss = 1.252072, step = 13901 (0.118 sec)
INFO:tensorflow:global_step/sec: 852.854
INFO:tensorflow:loss = 1.1639926, step = 14001 (0.117 sec)
INFO:tensorflow:global_step/sec: 845.622
INFO:tensorflow:loss = 1.4577808, step = 14101 (0.118 sec)
INFO:tensorflow:global_step/sec: 849.046
INFO:tensorflow:loss = 0.71012676, step = 14201 (0.118 sec)
INFO:tensorflow:global_step/sec: 848.57
INFO:tensorflow:loss = 1.0468352, step = 14301 (0.118 sec)
INFO:tensorflow:global_step/sec: 849.469
INFO:tensorflow:loss = 0.571285, step = 14401 (0.118 sec)
INFO:tensorflow:global_step/sec: 846.706
INFO:tensorflow:loss = 0.53165936, step = 14501 (0.118 sec)
INFO:tensorflow:global_step/sec: 846.496
INFO:tensorflow:loss = 0.44495654, step = 14601 (0.118 sec)
INFO:tensorflow:global_step/sec: 847.36
INFO:tensorflow:loss = 0.65011966, step = 14701 (0.118 sec)
INFO:tensorflow:global_step/sec: 847.651
INFO:tensorflow:loss = 0.82284653, step = 14801 (0.118 sec)
INFO:tensorflow:global_step/sec: 845.169
INFO:tensorflow:loss = 1.4069948, step = 14901 (0.118 sec)
INFO:tensorflow:global_step/sec: 844.188
INFO:tensorflow:loss = 0.8576143, step = 15001 (0.118 sec)
INFO:tensorflow:global_step/sec: 846.16
```

```
INFO:tensorflow:loss = 0.8265418, step = 15101 (0.118 sec)
INFO:tensorflow:global_step/sec: 850.601
INFO:tensorflow:loss = 1.3712791, step = 15201 (0.118 sec)
INFO:tensorflow:global_step/sec: 849.048
INFO:tensorflow:loss = 1.4091072, step = 15301 (0.118 sec)
INFO:tensorflow:global_step/sec: 846.341
INFO:tensorflow:loss = 0.88341904, step = 15401 (0.118 sec)
INFO:tensorflow:global_step/sec: 846.36
INFO:tensorflow:loss = 1.6313787, step = 15501 (0.118 sec)
INFO:tensorflow:global_step/sec: 848.847
INFO:tensorflow:loss = 0.66598713, step = 15601 (0.118 sec)
INFO:tensorflow:global_step/sec: 847.887
INFO:tensorflow:loss = 1.044811, step = 15701 (0.118 sec)
INFO:tensorflow:global_step/sec: 846.867
INFO:tensorflow:loss = 0.908123, step = 15801 (0.118 sec)
INFO:tensorflow:global_step/sec: 843.183
INFO:tensorflow:loss = 0.89812547, step = 15901 (0.119 sec)
INFO:tensorflow:global_step/sec: 846.626
INFO:tensorflow:loss = 0.7061515, step = 16001 (0.118 sec)
INFO:tensorflow:global_step/sec: 848.826
INFO:tensorflow:loss = 0.5160843, step = 16101 (0.118 sec)
INFO:tensorflow:global_step/sec: 848.553
INFO:tensorflow:loss = 0.9904233, step = 16201 (0.118 sec)
INFO:tensorflow:global_step/sec: 848.242
INFO:tensorflow:loss = 0.9242103, step = 16301 (0.118 sec)
INFO:tensorflow:global_step/sec: 845.072
INFO:tensorflow:loss = 1.2304581, step = 16401 (0.118 sec)
INFO:tensorflow:global_step/sec: 847.74
INFO:tensorflow:loss = 0.87679076, step = 16501 (0.118 sec)
INFO:tensorflow:global_step/sec: 847.706
INFO:tensorflow:loss = 1.284941, step = 16601 (0.118 sec)
INFO:tensorflow:global_step/sec: 848.604
INFO:tensorflow:loss = 1.4628489, step = 16701 (0.118 sec)
INFO:tensorflow:global_step/sec: 849.91
INFO:tensorflow:loss = 1.1282966, step = 16801 (0.118 sec)
INFO:tensorflow:global_step/sec: 849.694
INFO:tensorflow:loss = 1.2489524, step = 16901 (0.118 sec)
INFO:tensorflow:global_step/sec: 850.592
INFO:tensorflow:loss = 1.4547457, step = 17001 (0.118 sec)
INFO:tensorflow:global_step/sec: 849.552
INFO:tensorflow:loss = 0.7694609, step = 17101 (0.118 sec)
INFO:tensorflow:global_step/sec: 848.809
INFO:tensorflow:loss = 1.244573, step = 17201 (0.118 sec)
INFO:tensorflow:global_step/sec: 849.092
INFO:tensorflow:loss = 0.9516573, step = 17301 (0.118 sec)
INFO:tensorflow:global_step/sec: 845.157
INFO:tensorflow:loss = 0.7868532, step = 17401 (0.118 sec)
INFO:tensorflow:global_step/sec: 849.555
```

```
INFO:tensorflow:loss = 0.9301765, step = 17501 (0.118 sec)
INFO:tensorflow:global_step/sec: 851.164
INFO:tensorflow:loss = 0.6153618, step = 17601 (0.118 sec)
INFO:tensorflow:global_step/sec: 846.156
INFO:tensorflow:loss = 0.41946757, step = 17701 (0.118 sec)
INFO:tensorflow:global_step/sec: 851.509
INFO:tensorflow:loss = 0.74128187, step = 17801 (0.117 sec)
INFO:tensorflow:global_step/sec: 847.136
INFO:tensorflow:loss = 0.38839713, step = 17901 (0.118 sec)
INFO:tensorflow:global_step/sec: 844.878
INFO:tensorflow:loss = 0.44792655, step = 18001 (0.118 sec)
INFO:tensorflow:global_step/sec: 851.015
INFO:tensorflow:loss = 0.8803854, step = 18101 (0.118 sec)
INFO:tensorflow:global_step/sec: 850.799
INFO:tensorflow:loss = 0.47697282, step = 18201 (0.118 sec)
INFO:tensorflow:global_step/sec: 849.189
INFO:tensorflow:loss = 0.7780204, step = 18301 (0.118 sec)
INFO:tensorflow:global_step/sec: 849.132
INFO:tensorflow:loss = 1.0835747, step = 18401 (0.118 sec)
INFO:tensorflow:global_step/sec: 850.18
INFO:tensorflow:loss = 0.5465142, step = 18501 (0.118 sec)
INFO:tensorflow:global_step/sec: 849.469
INFO:tensorflow:loss = 1.0605328, step = 18601 (0.118 sec)
INFO:tensorflow:global_step/sec: 844.276
INFO:tensorflow:loss = 0.5382986, step = 18701 (0.118 sec)
INFO:tensorflow:global_step/sec: 842.847
INFO:tensorflow:loss = 1.0240496, step = 18801 (0.119 sec)
INFO:tensorflow:global_step/sec: 840.796
INFO:tensorflow:loss = 0.8277434, step = 18901 (0.119 sec)
INFO:tensorflow:global_step/sec: 848.493
INFO:tensorflow:loss = 0.6375053, step = 19001 (0.118 sec)
INFO:tensorflow:global_step/sec: 845.955
INFO:tensorflow:loss = 0.47816133, step = 19101 (0.118 sec)
INFO:tensorflow:global_step/sec: 845.842
INFO:tensorflow:loss = 0.9890578, step = 19201 (0.118 sec)
INFO:tensorflow:global_step/sec: 847.5
INFO:tensorflow:loss = 0.80507964, step = 19301 (0.118 sec)
INFO:tensorflow:global_step/sec: 846.44
INFO:tensorflow:loss = 0.7437234, step = 19401 (0.118 sec)
INFO:tensorflow:global_step/sec: 842.018
INFO:tensorflow:loss = 0.75430524, step = 19501 (0.119 sec)
INFO:tensorflow:global_step/sec: 846.941
INFO:tensorflow:loss = 1.0380011, step = 19601 (0.118 sec)
INFO:tensorflow:global_step/sec: 848.795
INFO:tensorflow:loss = 0.4550801, step = 19701 (0.118 sec)
INFO:tensorflow:global_step/sec: 853.222
INFO:tensorflow:loss = 0.7005102, step = 19801 (0.117 sec)
INFO:tensorflow:global_step/sec: 847.872
```

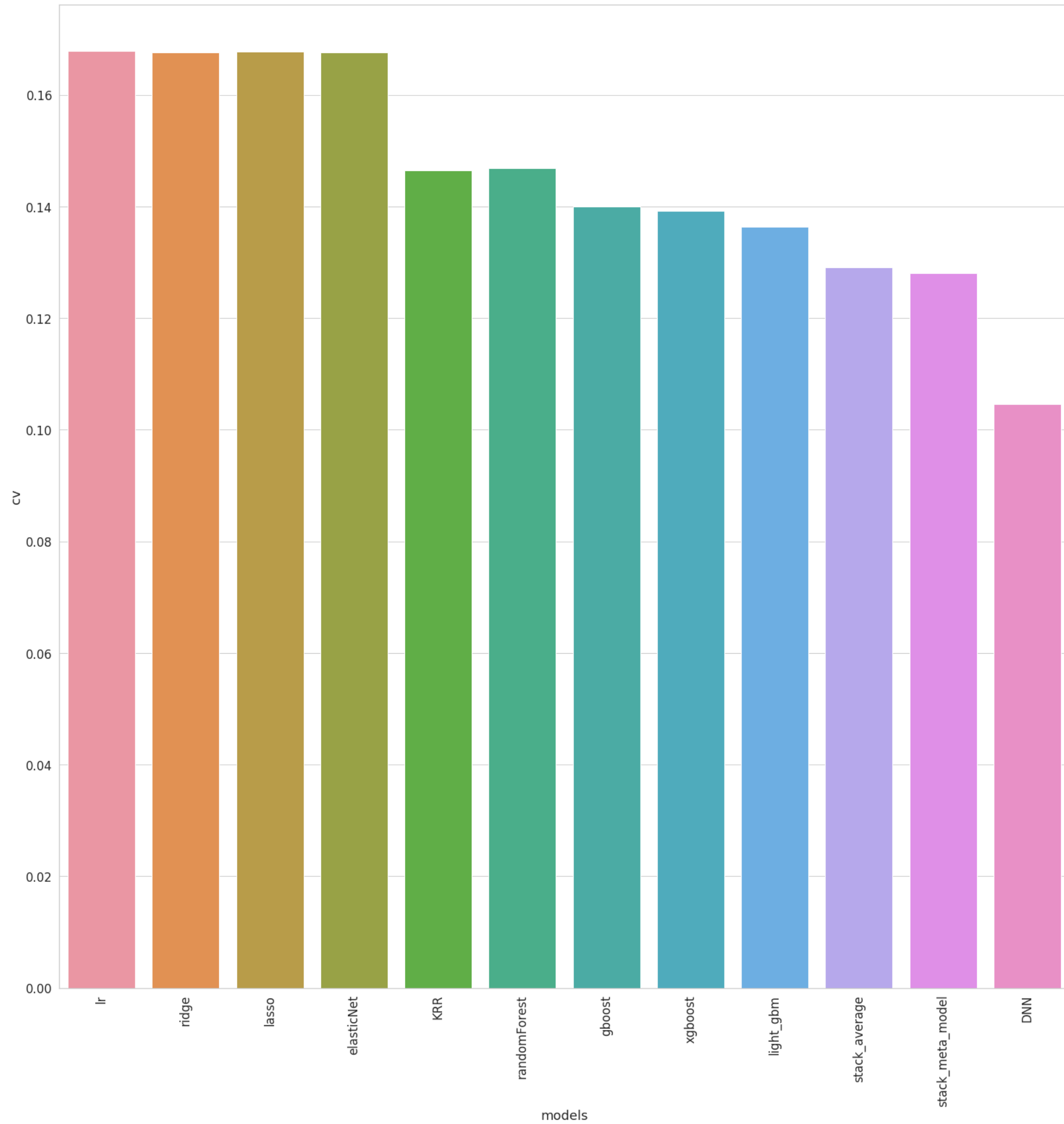
```
INFO:tensorflow:loss = 0.7187972, step = 19901 (0.118 sec)
INFO:tensorflow:Saving checkpoints for 20000 into /tmp/tmpbzhhoamp/model.ckpt.
INFO:tensorflow:Loss for final step: 0.47970742.
```

```
Out[189]: <tensorflow_estimator.python.estimator.canned.dnn.DNNRegressor at 0x7f5ca8514e80>
```

```
In [190]: y_train_pred = []
          for pred in dnn_model.predict(input_fn=train_input_func):
              y_train_pred.append(pred['predictions'][0])
          df_rmse['cv'][11] = np.sqrt(mean_squared_error(y_train_pred,y_train))
```

```
INFO:tensorflow:Calling model_fn.
INFO:tensorflow:Done calling model_fn.
INFO:tensorflow:Graph was finalized.
INFO:tensorflow:Restoring parameters from /tmp/tmpbzhhoamp/model.ckpt-20000
INFO:tensorflow:Running local_init_op.
INFO:tensorflow:Done running local_init_op.
```

```
In [191]: with sns.axes_style("whitegrid", {'axes.grid' : True}):
              fig, ax = plt.subplots(1,1, figsize=(25,25))
          sns.set(font_scale=1.5)

          sns.barplot(x = 'models', y = 'cv', data=df_rmse)
          plt.xticks(rotation=90)
          plt.show()
```



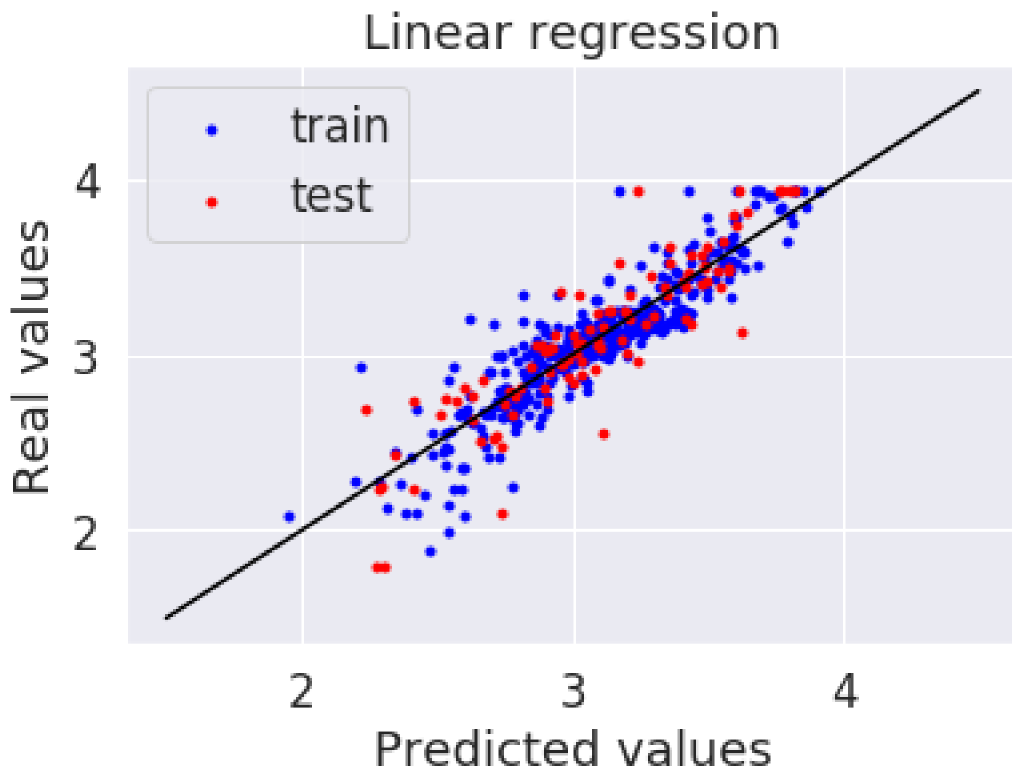
As you can see the bar plot, basic 4 models(linear,ridge,lasso and elasticnet) have higher bias than other advanced models and Deep Neural Network performed best on a train set.

-

1.5 Evaluation on test (or dev) set

```
In [192]: lr.fit(X_train, y_train)
          y_train_pred = lr.predict(X_train)
          y_test_pred = lr.predict(X_test)
          # Plot predictions
```

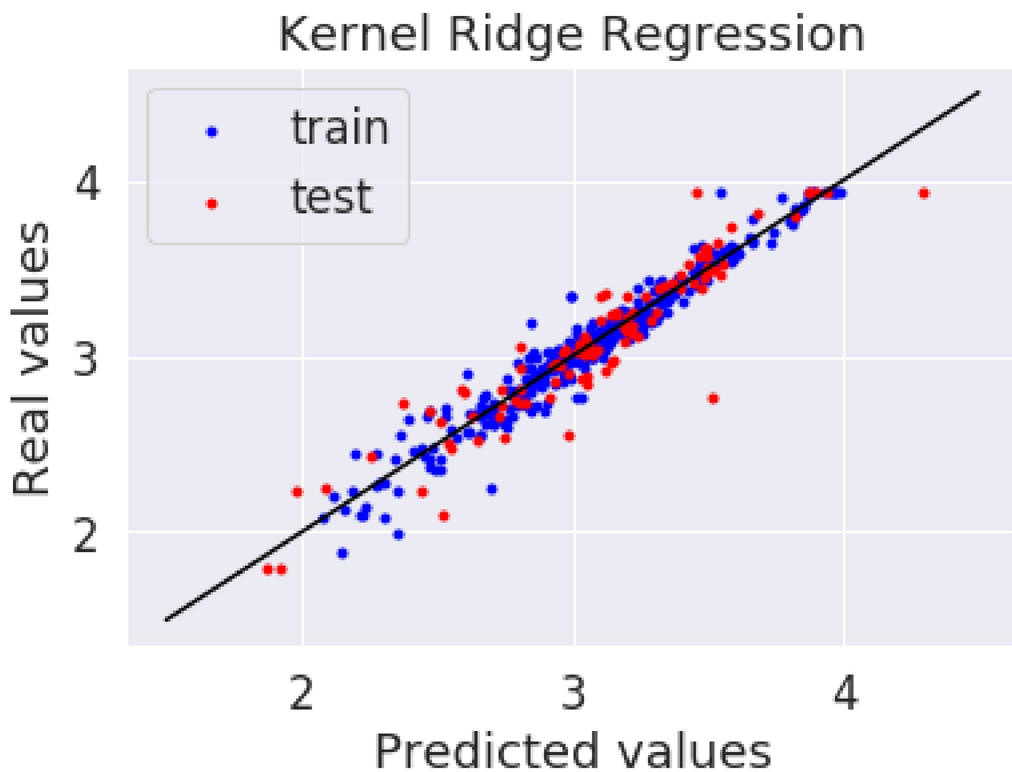
```
plt.scatter(y_train_pred, y_train, c = "blue", marker = ".", label = "train")
plt.scatter(y_test_pred, y_test, c = "red", marker = ".", label = "test")
plt.title("Linear regression")
plt.xlabel("Predicted values")
plt.ylabel("Real values")
plt.legend(loc = "upper left")
plt.plot([1.5, 4.5], [1.5, 4.5], c = "black")
plt.show()
```




```
In [193]: df_rmse['test'][0] = np.sqrt(mean_squared_error(y_test_pred,y_test))

In [194]: ridge.fit(X_train, y_train)
          y_test_pred = ridge.predict(X_test)
          df_rmse['test'][1] = np.sqrt(mean_squared_error(y_test_pred,y_test))

In [195]: lasso.fit(X_train, y_train)
          y_test_pred = lasso.predict(X_test)
          df_rmse['test'][2] = np.sqrt(mean_squared_error(y_test_pred,y_test))

In [197]: elasticNet.fit(X_train, y_train)
          y_test_pred = elasticNet.predict(X_test)
          df_rmse['test'][3] = np.sqrt(mean_squared_error(y_test_pred,y_test))
```

```
In [198]: KRR.fit(X_train, y_train)
          y_test_pred = KRR.predict(X_test)
          df_rmse['test'][4] = np.sqrt(mean_squared_error(y_test_pred,y_test))
```

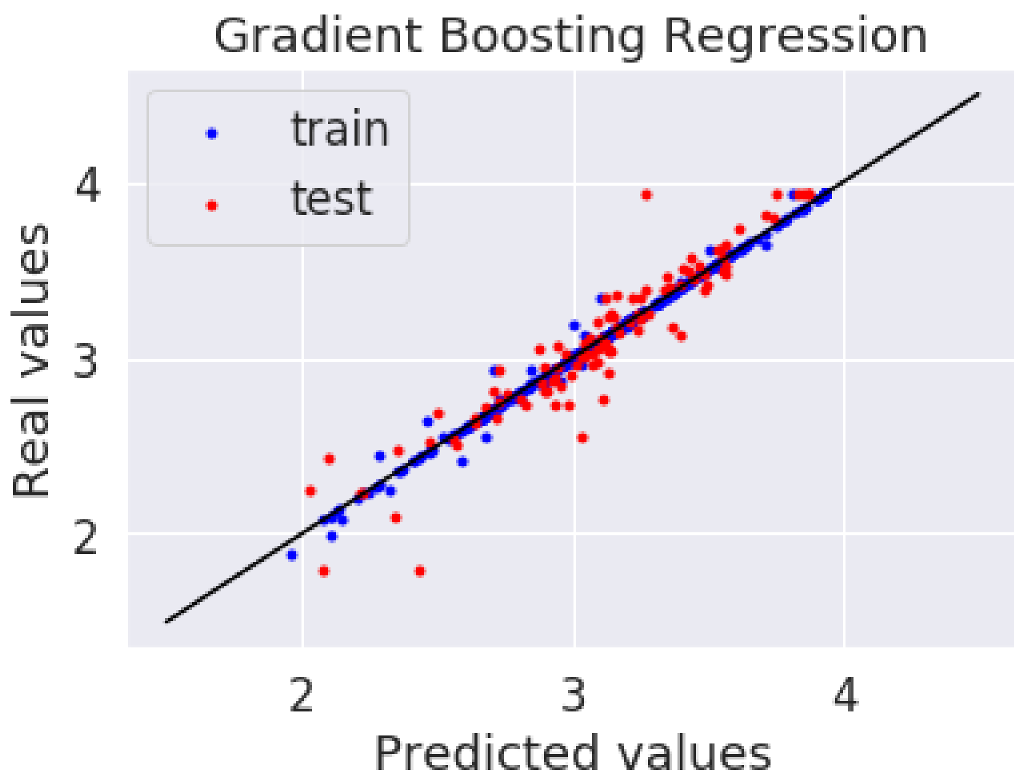
```
In [199]: y_train_pred = KRR.predict(X_train)
          y_test_pred = KRR.predict(X_test)
          plt.scatter(y_train_pred, y_train, c = "blue", marker = ".", label = "train")
          plt.scatter(y_test_pred, y_test, c = "red", marker = ".", label = "test")
          plt.title("Kernel Ridge Regression")
          plt.xlabel("Predicted values")
          plt.ylabel("Real values")
          plt.legend(loc = "upper left")
          plt.plot([1.5, 4.5], [1.5, 4.5], c = "black")
          plt.show()
```




```
In [200]: randomForest.fit(X_train, y_train)
          y_test_pred = randomForest.predict(X_test)
          df_rmse['test'][5] = np.sqrt(mean_squared_error(y_test_pred,y_test))
```

```
In [201]: gboost.fit(X_train, y_train)
          y_test_pred = gboost.predict(X_test)
          df_rmse['test'][6] = np.sqrt(mean_squared_error(y_test_pred,y_test))
```

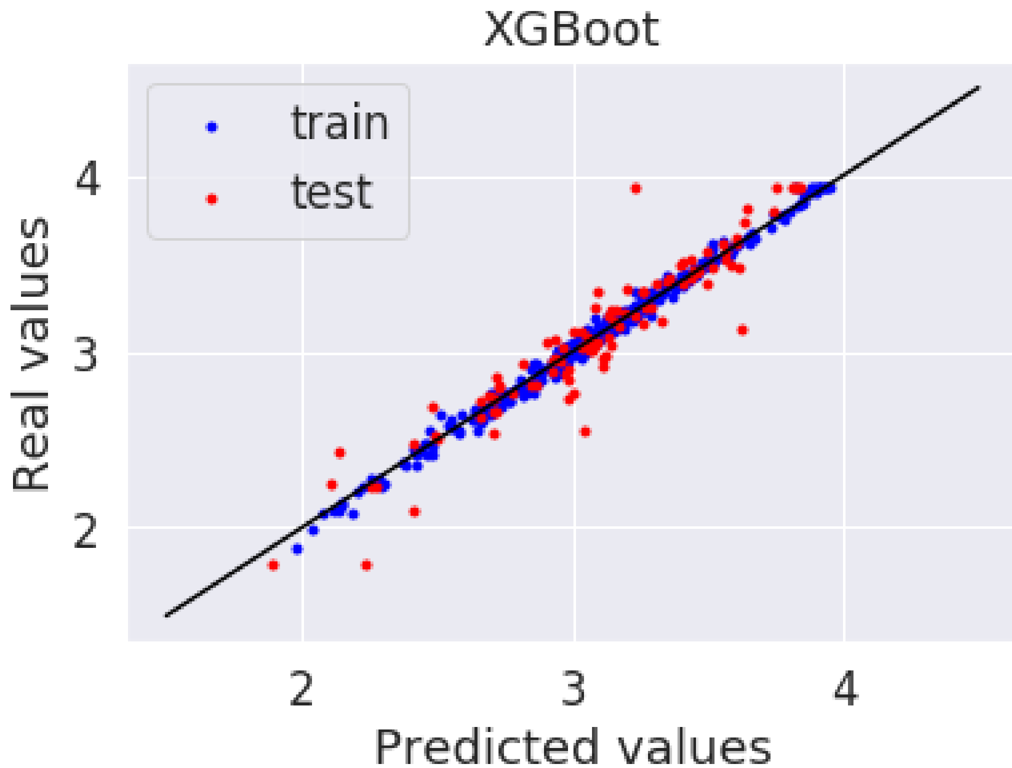
In [202]:
```
y_train_pred = gboost.predict(X_train)
y_test_pred = gboost.predict(X_test)
# Plot predictions
plt.scatter(y_train_pred, y_train, c = "blue", marker = ".", label = "train")
plt.scatter(y_test_pred, y_test, c = "red", marker = ".", label = "test")
plt.title("Gradient Boosting Regression")
plt.xlabel("Predicted values")
plt.ylabel("Real values")
plt.legend(loc = "upper left")
plt.plot([1.5, 4.5], [1.5, 4.5], c = "black")
plt.show()
```



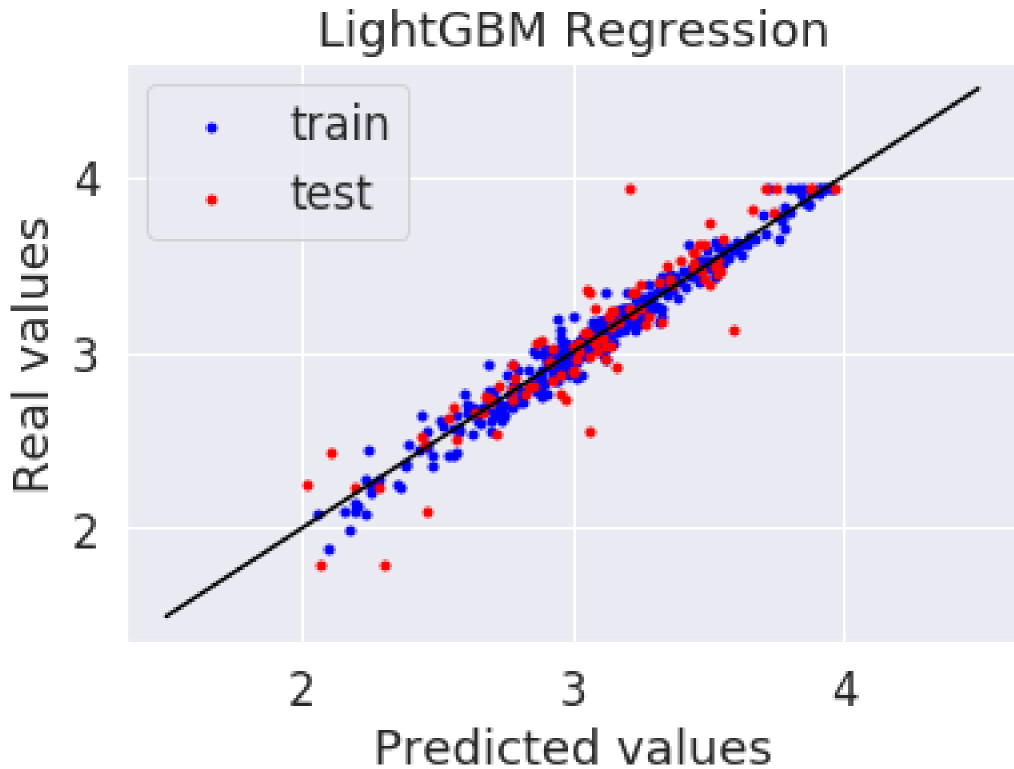
In [203]:
```
xgboost.fit(X_train, y_train)
y_test_pred = xgboost.predict(X_test)
df_rmse['test'][7] = np.sqrt(mean_squared_error(y_test_pred,y_test))
```

In [204]:
```
y_train_pred = xgboost.predict(X_train)
y_test_pred = xgboost.predict(X_test)
# Plot predictions
plt.scatter(y_train_pred, y_train, c = "blue", marker = ".", label = "train")
plt.scatter(y_test_pred, y_test, c = "red", marker = ".", label = "test")
plt.title("XGBoot")
```

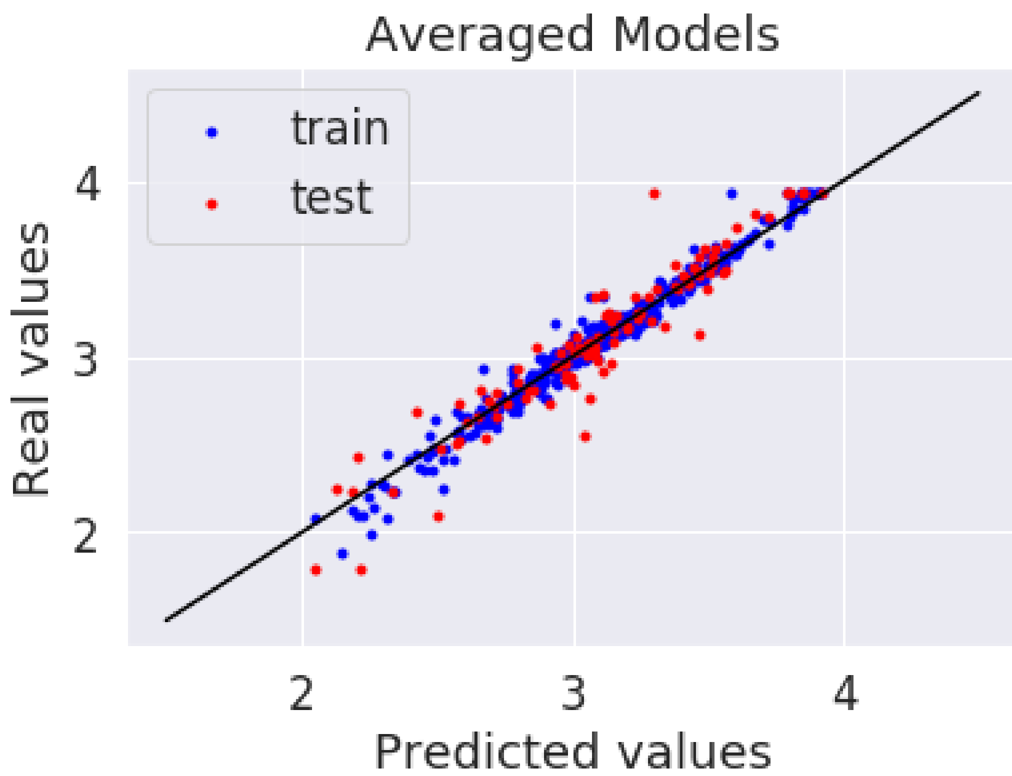
```
plt.xlabel("Predicted values")
plt.ylabel("Real values")
plt.legend(loc = "upper left")
plt.plot([1.5, 4.5], [1.5, 4.5], c = "black")
plt.show()
```




```
In [205]: light_gbm.fit(X_train, y_train)
          y_test_pred = light_gbm.predict(X_test)
          df_rmse['test'][8] = np.sqrt(mean_squared_error(y_test_pred,y_test))

In [206]: y_train_pred = light_gbm.predict(X_train)
          y_test_pred = light_gbm.predict(X_test)
          # Plot predictions
          plt.scatter(y_train_pred, y_train, c = "blue", marker = ".", label = "train")
          plt.scatter(y_test_pred, y_test, c = "red", marker = ".", label = "test")
          plt.title("LightGBM Regression")
          plt.xlabel("Predicted values")
          plt.ylabel("Real values")
          plt.legend(loc = "upper left")
          plt.plot([1.5, 4.5], [1.5, 4.5], c = "black")
          plt.show()
```




```
In [207]: averaged_models.fit(X_train, y_train)
          averaged_models_pred = averaged_models.predict(X_test)
          df_rmse['test'][9] = np.sqrt(mean_squared_error(averaged_models_pred,y_test))

In [208]: y_train_pred = averaged_models.predict(X_train)
          y_test_pred = averaged_models.predict(X_test)
          # Plot predictions
          plt.scatter(y_train_pred, y_train, c = "blue", marker = ".", label = "train")
          plt.scatter(y_test_pred, y_test, c = "red", marker = ".", label = "test")
          plt.title("Averaged Models")
          plt.xlabel("Predicted values")
          plt.ylabel("Real values")
          plt.legend(loc = "upper left")
          plt.plot([1.5, 4.5], [1.5, 4.5], c = "black")
          plt.show()
```

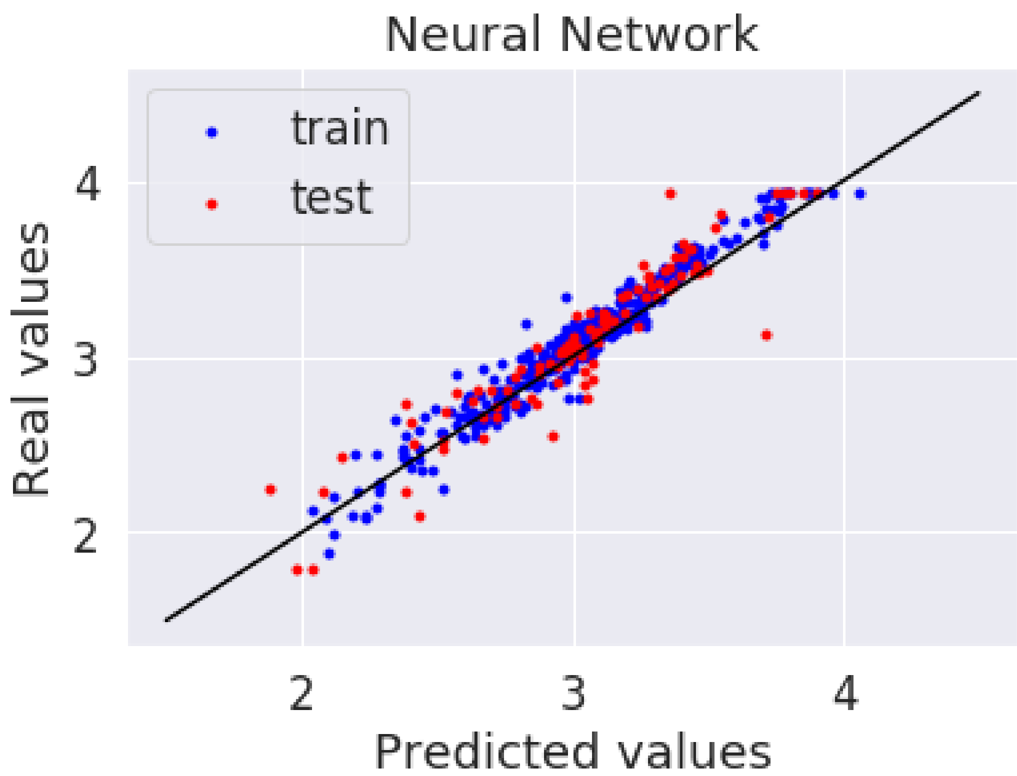



```
In [209]: stacked_averaged_models.fit(X_train, y_train)
          stacked_averaged_models_pred = stacked_averaged_models.predict(X_test)

In [211]: xgboost.fit(X_train, y_train)
          xgboost_pred = xgboost.predict(X_test)

In [212]: average = (stacked_averaged_models_pred*0.5 + xgboost_pred * 0.5)

In [213]: df_rmse['test'][10]  = np.sqrt(mean_squared_error(average,y_test))

In [214]: y_test_pred = []
          for pred in dnn_model.predict(input_fn=eval_input_func):
              y_test_pred.append(pred['predictions'][0])
          df_rmse['test'][11] = np.sqrt(mean_squared_error(y_test_pred,y_test))
```

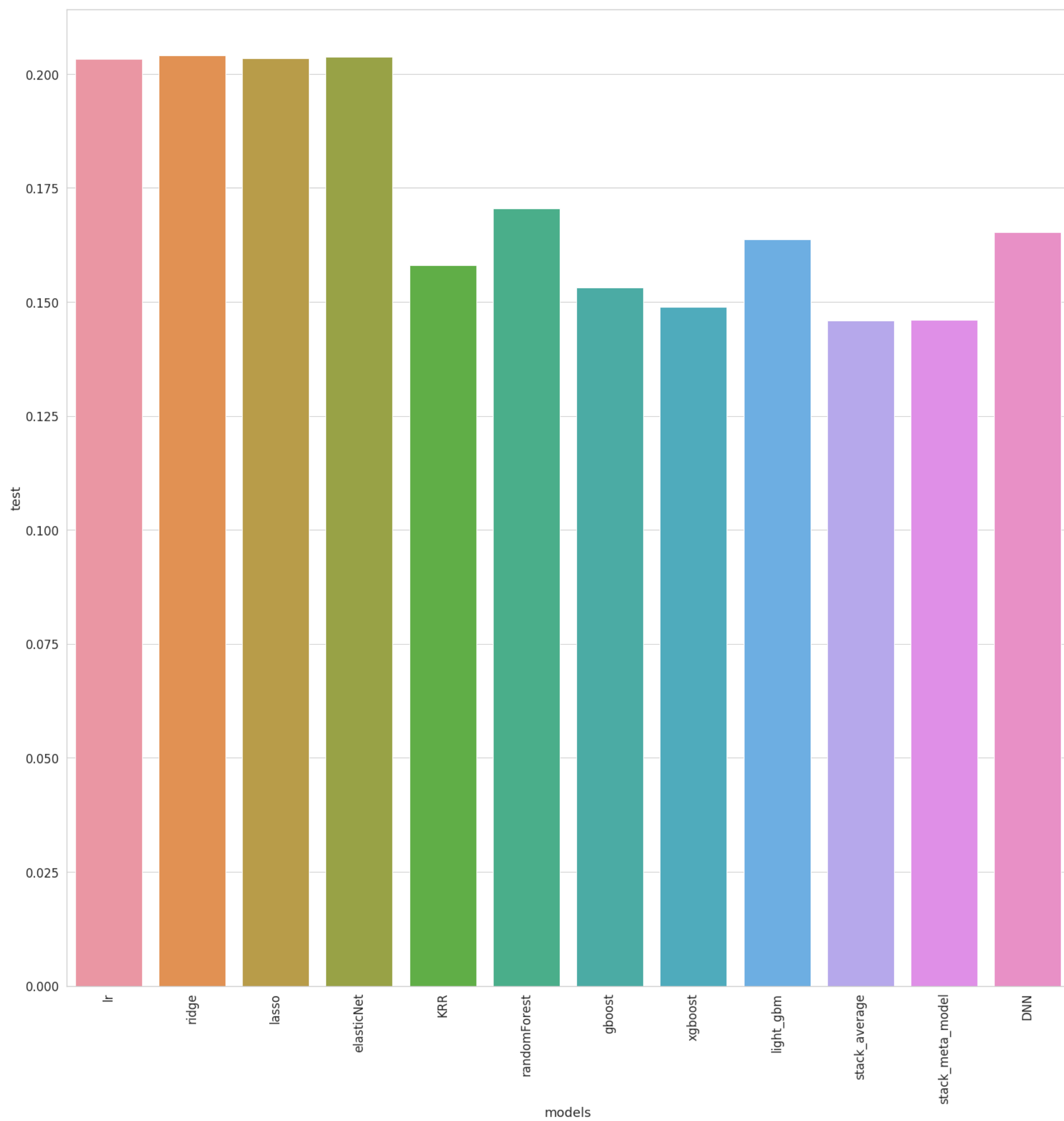
```
INFO:tensorflow:Calling model_fn.
INFO:tensorflow:Done calling model_fn.
INFO:tensorflow:Graph was finalized.
INFO:tensorflow:Restoring parameters from /tmp/tmpbzhhoamp/model.ckpt-20000
INFO:tensorflow:Running local_init_op.
INFO:tensorflow:Done running local_init_op.
```

```
In [215]: y_train_pred = []
          for pred in dnn_model.predict(input_fn=train_input_func):
              y_train_pred.append(pred['predictions'][0])

          y_test_pred = []
          for pred in dnn_model.predict(input_fn=eval_input_func):
              y_test_pred.append(pred['predictions'][0])

          plt.scatter(y_train_pred, y_train, c = "blue", marker = ".", label = "train")
          plt.scatter(y_test_pred, y_test, c = "red", marker = ".", label = "test")
          plt.title("Neural Network")
          plt.xlabel("Predicted values")
          plt.ylabel("Real values")
          plt.legend(loc = "upper left")
          plt.plot([1.5, 4.5], [1.5, 4.5], c = "black")
          plt.show()
```

```
INFO:tensorflow:Calling model_fn.
INFO:tensorflow:Done calling model_fn.
INFO:tensorflow:Graph was finalized.
INFO:tensorflow:Restoring parameters from /tmp/tmpbzhhoamp/model.ckpt-20000
INFO:tensorflow:Running local_init_op.
INFO:tensorflow:Done running local_init_op.
INFO:tensorflow:Calling model_fn.
INFO:tensorflow:Done calling model_fn.
INFO:tensorflow:Graph was finalized.
INFO:tensorflow:Restoring parameters from /tmp/tmpbzhhoamp/model.ckpt-20000
INFO:tensorflow:Running local_init_op.
INFO:tensorflow:Done running local_init_op.
```



In [216]:
```
with sns.axes_style("whitegrid", {'axes.grid' : True}):
    fig, ax = plt.subplots(1,1, figsize=(25,25))
sns.set(font_scale=1.5)

sns.barplot(x = 'models', y = 'test', data=df_rmse)
plt.xticks(rotation=90)
plt.show()
```



This plot shows RMSE on a test set(unseen data). It seems that DNN was our best regressor on a cross validation, but on the test set, DNN got high variance. Simeple Stack Average model and stack meta model got the lowest RSME.

```
In [ ]:
```