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    "# Predicting if a Blood Donor will donate within a given time window"
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    "While working for Rotaract Club of MSIT from last 3 years one of my main responsibility was to organise Blood Donation Camps, and it is an amazing event to organise because it gives you a feeling that you are helping for a right cause which saves life.\n",
    "\n",
    "### Problem\n",
    "One of the major problem while organising the Blood Donation Camp was that to convince the people who were walking near the camp to be a donor which results in 70% of the people were not interesting in donating due to reasons like they have work to do, they need to go somewhere etc.\n",
    "There's this one time in every year when we organise a blood donation camp in Adarsh Public School, New Delhi on the day of parent teacher meeting, so parents were already told about the donation camp and almost 80-90% of the parents become donors. \n",
    "\n",
    "So, I thought that if before organising the event we could we could reach out to the right people before the donation then we will get more donors and can save more lives. As part of making records we were collecting data of the volunteers from last 2 years and contains details of there address but it was not well organised.\n",
    "\n",
    "So I googled it.\n",
    "\n",
    "I found the data that I needed from [Drivendata](https://www.drivendata.org/competitions/2/warm-up-predict-blood-donations/data/).\n",
    "\n",
    "### Use information about each donor's history\n",
    "- Months since Last Donation: this is the number of monthis since this donor's most recent donation.\n",
    "- Number of Donations: this is the total number of donations that the donor has made.\n",
    "- Total Volume Donated: this is the total amound of blood that the donor has donated in cubuc centimeters.\n",
    "- Months since First Donation: this is the number of months since the donor's first donation."
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    "The data are pre-split into training and test sets, so weâll read them in separately. "
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  "import numpy as np\n",
  "import seaborn as sns\n",
  "import matplotlib\n",
  "import matplotlib.pyplot as plt\n",
  "%matplotlib inline"
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    "test = pd.read_csv(\"test.csv\")\n",
    "test.columns =
['id','months_since_last_donation','num_donations','vol_donations','months_since
_first_donation']\n",
    "IDtest = test[\"id\"]\n",
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    "print(df.isnull().sum())\n",
    "df.head(5)"
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    "The good thing is we have no missing values and we have 576 rows and 6
Columns. The features are 'Months since Last Donation', 'Number of Donations',
'Total Volume Donated', 'Months since First Donation'.\n",
    "\n",
    "In the class column there are two classes\n",
    "- class 1 : The donor donated blood in March 2007.\n",
    "- class 0 : The donor did not donate blood in March 2007.\n",
    "\n",
    "Note : I am asuming that 1 means donated and 0 means not donated"
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    "# Outliers Detection\n",
    "Since outliers can have a dramatic effect on the prediction (espacially for
regression problems), i choosed to manage them.\n",
    "\n",
    "The Tukey method (Tukey JW., 1977) is used to detect ouliers which defines
an interquartile range comprised between the 1st and 3rd quartile of the
distribution values (IQR). An outlier is a row that have a feature value outside
the (IQR +- an outlier step).\n",
    "\n",
    "Detected the outliers from the numerical values features (Age, SibSp, Sarch
and Fare). Then, considered outliers as rows that have at least two outlied
numerical values."
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    "from collections import Counter\n",
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    "# Outlier detection \n",
    "def detect_outliers(df,n,features):\n",
    "    \"\"\"\n",
    "    Takes a dataframe of features and returns a list of the indices\n",
```

```
    "    corresponding to the observations containing more than n outliers according\n",
    "    to the Tukey method.\n",
    "    \"\"\"\n",
    "    outlier_indices = []\n",
    "    \n",
    "    # iterate over features(columns)\n",
    "    for col in features:\n",
    "        # 1st quartile (25%)\n",
    "        Q1 = np.percentile(df[col], 25)\n",
    "        # 3rd quartile (75%)\n",
    "        Q3 = np.percentile(df[col],75)\n",
    "        # Interquartile range (IQR)\n",
    "        IQR = Q3 - Q1\n",
    "        \n",
    "        # outlier step\n",
    "        outlier_step = 1.5 * IQR\n",
    "        \n",
    "        # Determine a list of indices of outliers for feature col\n",
    "        outlier_list_col = df[(df[col] < Q1 - outlier_step) | (df[col] > Q3 + outlier_step )].index\n",
    "        \n",
    "        # append the found outlier indices for col to the list of outlier indices \n",
    "        outlier_indices.extend(outlier_list_col)\n",
    "        \n",
    "    # select observations containing more than 2 outliers\n",
    "    outlier_indices = Counter(outlier_indices)        \n",
    "    multiple_outliers = list( k for k, v in outlier_indices.items() if v > n )\n",
    "    \n",
    "    return multiple_outliers   \n",
    "\n",
    "# detect outliers from Age, SibSp , Parch and Fare\n",
    "Outliers_to_drop = detect_outliers(df,2,[\"months_since_last_donation\",\"num_donations\",\"vol_donations\",\"months_since_first_donation\"])"
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  "# Fill empty and NaNs values with NaN\n",
  "dataset = dataset.fillna(np.nan)\n",
  "# Check for Null values\n",
  "dataset.isnull().sum()"
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    "               y='vol_donations',\n",
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SettingWithCopyWarning: \n",
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      "\n",
      "See the caveats in the documentation: http://pandas.pydata.org/pandas-
docs/stable/indexing.html#indexing-view-versus-copy\n",
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    "train = dataset[:train_len]\n",
    "test = dataset[train_len:]\n",
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      "\n",
      "See the caveats in the documentation: http://pandas.pydata.org/pandas-
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    "X_train = train.drop(labels = [\"class\"],axis = 1)"
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    "sc = StandardScaler()\n",
    "X_train_scaled = sc.fit_transform(X_train)"
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    "I compared 10 popular classifiers and evaluate the mean accuracy of each of
```

them by a stratified kfold cross validation procedure.\n",
    "\n",
    "- SVC\n",
    "- Decision Tree\n",
    "- AdaBoost\n",
    "- Random Forest\n",
    "- Extra Trees\n",
    "- Gradient Boosting\n",
    "- Multiple layer perceprton (neural network)\n",
    "- KNN\n",
    "- Logistic regression\n",
    "- Linear Discriminant Analysis"
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    "\n",
    "from sklearn.ensemble import RandomForestClassifier, AdaBoostClassifier,
GradientBoostingClassifier, ExtraTreesClassifier, VotingClassifier\n",
    "from sklearn.discriminant_analysis import LinearDiscriminantAnalysis\n",
    "from sklearn.linear_model import LogisticRegression\n",
    "from sklearn.neighbors import KNeighborsClassifier\n",
    "from sklearn.tree import DecisionTreeClassifier\n",
    "from sklearn.neural_network import MLPClassifier\n",
    "from sklearn.svm import SVC\n",
    "from sklearn.model_selection import GridSearchCV, cross_val_score,
StratifiedKFold, learning_curve"
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```

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"\"RandomForest\",\"ExtraTrees\",\"GradientBoosting\",\"MultipleLayerPerceptron\
",\"KNeighboors\",\"LogisticRegression\",\"LinearDiscriminantAnalysis\"]})\n",
    "\n",
    "g = sns.barplot(\"CrossValMeans\",\"Algorithm\",data = cv_res,
palette=\"Set3\",orient = \"h\",**{'xerr':cv_std})\n",
    "g.set_xlabel(\"Mean Accuracy\")\n",
    "g = g.set_title(\"Cross validation scores\")"
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    "By seeing the figure we can see that Random Forest, Extra Trees, Gradient
Boosting Classifiers will work the best."
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    "I performed a grid search optimization for Random Forest, Extra Trees,
Gradient Boosting, SVC classifiers.\n",
    "I set the \"n_jobs\" parameter to 4 since i have 4 cpu . The computation
time is clearly reduced."
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    "RFC = RandomForestClassifier()\n",
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    "\n",
    "## Search grid for optimal parameters\n",
    "rf_param_grid = {\"max_depth\": [80, 90, 100, 110],\n",
    "              \"max_features\": [2, 3],\n",
    "              \"min_samples_split\": [8, 10, 12],\n",
    "              \"min_samples_leaf\": [3, 4, 5],\n",
    "              \"bootstrap\": [False],\n",
    "              \"n_estimators\" :[100, 200, 300, 1000],\n",
    "              \"criterion\": [\"gini\"]}\n",
    "\n",
    "\n",
    "gsRFC = GridSearchCV(RFC,param_grid = rf_param_grid, cv=kfold,
scoring=\"accuracy\", n_jobs= 4, verbose = 1)\n",
    "\n",
    "gsRFC.fit(X_train_scaled,Y_train)\n",
    "\n",
    "RFC_best = gsRFC.best_estimator_\n",
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    "# Best score\n",
    "gsRFC.best_score_"
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    "#ExtraTrees \n",
```

```
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    "\n",
    "\n",
    "## Search grid for optimal parameters\n",
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    "              \"max_features\": [2, 3],\n",
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    "              \"n_estimators\" :[100, 200, 300, 1000],\n",
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    "\n",
    "gsExtC = GridSearchCV(ExtC,param_grid = ex_param_grid, cv=kfold,
scoring=\"accuracy\", n_jobs= 4, verbose = 1)\n",
    "\n",
    "gsExtC.fit(X_train_scaled,Y_train)\n",
    "\n",
    "ExtC_best = gsExtC.best_estimator_\n",
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    "# Best score\n",
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    "gb_param_grid = {'loss' : [\"deviance\"],\n",
    "              'n_estimators' : [100,200,300],\n",
    "              'learning_rate': [0.1, 0.05, 0.01],\n",
```

```
    "              'max_depth': [4, 8],\n",
    "              'min_samples_leaf': [100,150],\n",
    "              'max_features': [0.3, 0.1] \n",
    "              }\n",
    "\n",
    "gsGBC = GridSearchCV(GBC,param_grid = gb_param_grid, cv=kfold,
scoring=\"accuracy\", n_jobs= 4, verbose = 1)\n",
    "\n",
    "gsGBC.fit(X_train_scaled,Y_train)\n",
    "\n",
    "GBC_best = gsGBC.best_estimator_\n",
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    "svc_param_grid = {'kernel': ['rbf'], \n",
    "                  'gamma': [ 0.001, 0.01, 0.1, 1],\n",
    "                  'C': [1, 10, 50, 100,200,300, 1000]}\n",
    "\n",
    "gsSVMC = GridSearchCV(SVMC,param_grid = svc_param_grid, cv=kfold,
scoring=\"accuracy\", n_jobs= 4, verbose = 1)\n",
    "\n",
    "gsSVMC.fit(X_train_scaled,Y_train)\n",
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    "SVMC_best = gsSVMC.best_estimator_\n",
    "\n",
    "# Best score\n",
```

```
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     "# Plot learning curve\n",
     "def plot_learning_curve(estimator, title, X, y, ylim=None, cv=None,\n",
     "                        n_jobs=-1, train_sizes=np.linspace(.1, 1.0, 5)):\
n",
     "    \"\"\"Generate a simple plot of the test and training learning
curve\"\"\"\n",
     "    plt.figure()\n",
     "    plt.title(title)\n",
     "    if ylim is not None:\n",
     "        plt.ylim(*ylim)\n",
     "    plt.xlabel(\"Training examples\")\n",
     "    plt.ylabel(\"Score\")\n",
     "    train_sizes, train_scores, test_scores = learning_curve(\n",
     "        estimator, X, y, cv=cv, n_jobs=n_jobs, train_sizes=train_sizes)\n",
     "    train_scores_mean = np.mean(train_scores, axis=1)\n",
     "    train_scores_std = np.std(train_scores, axis=1)\n",
     "    test_scores_mean = np.mean(test_scores, axis=1)\n",
     "    test_scores_std = np.std(test_scores, axis=1)\n",
     "    plt.grid()\n",
     "\n",
     "    plt.fill_between(train_sizes, train_scores_mean - train_scores_std,\n",
     "                     train_scores_mean + train_scores_std, alpha=0.1,\n",
     "                     color=\"r\")\n",
     "    plt.fill_between(train_sizes, test_scores_mean - test_scores_std,\n",
     "                     test_scores_mean + test_scores_std, alpha=0.1,
color=\"g\")\n",
     "    plt.plot(train_sizes, train_scores_mean, 'o-', color=\"r\",\n",
     "             label=\"Training score\")\n",
     "    plt.plot(train_sizes, test_scores_mean, 'o-', color=\"g\",\n",
     "             label=\"Cross-validation score\")\n",
```

```
    "\n",
    "    plt.legend(loc=\"best\")\n",
    "    return plt\n",
    "\n",
    "g = plot_learning_curve(gsRFC.best_estimator_,\"RF mearning curves\",X_train,Y_train,cv=kfold)\n",
    "g = plot_learning_curve(gsExtC.best_estimator_,\"ExtraTrees learning curves\",X_train,Y_train,cv=kfold)\n",
    "g = plot_learning_curve(gsGBC.best_estimator_,\"GradientBoosting learning curves\",X_train,Y_train,cv=kfold)\n",
    "g = plot_learning_curve(gsSVMC.best_estimator_,\"SVC learning curves\",X_train,Y_train,cv=kfold)"
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    " By looking at the learning curve GradientBoosting and ExtraTrees classifiers tend to overfit the training set. According to the growing cross-validation curves Random Forest classifier and SVC seems to better generalize the prediction since the training and cross-validation curves are close together."
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    "# Testing the models on test set\n",
    "\n",
    "So the we will use SVC classifier as a final model."
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    "# Scaling the test data\n",
    "test_scaled = sc.transform(test)\n",
    "# predicting the results\n",
    "predictions = gsSVMC.predict_proba(test_scaled)\n",
    "predictions = predictions[:,1]\n",
    "pred_report = pd.DataFrame(predictions.tolist(),index=IDtest,columns=[\"Made Donation in March 2007\"])"
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    "# saving the prediction\n",
    "pred_report.to_csv(\"final_submission.csv\")"
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```

```
    "# Conclusion"
   ]
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    "Now we can target the people who are interested in donating blood and which will results in getting more volunteers and we can save more people.\n",
    "\n",
    "For those interested, the Jupyter Notebook with all the code can be found in the [Github repository](https://github.com/souvikb07/Predict-Blood-Donations) for this post."
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