Mathematica Project: Analysis of Kiva Loans

Loans that change lives

Insights from Loans disbursed by Kiva

Kiva is a non-profit organization that allows people to lend money via the internet to low-income entrepreneurs. Kiva works with more than 300 microfinance institutions, social impact businesses, schools and non-profit organizations around the world, called “Field Partners” that post profiles of qualified local entrepreneurs on the Kiva website. Lenders browse borrower profiles on *kiva.org* and choose an entrepreneur they wish to fund. Lenders can loan money in increments as small as $25.

With the help of the Mathematica software, we will perform the analysis of **‘*Kiva Loans*’** data. The dataset is obtained from Kaggle and has more than 6 lakhs rows. We will use Mathematica for Exploratory Data Analysis. We will also apply Machine learning techniques such as Random Forests, Logistic Regression etc. for further analysis.

```
In[ ]:= csvdata =
  Import["/Users/vipinragashetti/Vipin/Workspace/UCD/semester-I/Mathematica
     for Research/Project/myproject/kiva_loans.csv"];
```

In[ ]:=
```
header = csvdata[[1]];
data = csvdata[[2 ;;]];
kivaloan = Thread[header → #] & /@ data // Map[Association] // Dataset
```

Out[ ]=

id	funded_amount	loan_amount	activity
653051	300.0	300.0	Fruits & Vegetables
653053	575.0	575.0	Rickshaw
653068	150.0	150.0	Transportation
653063	200.0	200.0	Embroidery
653084	400.0	400.0	Milk Sales
1080148	250.0	250.0	Services
653067	200.0	200.0	Dairy
653078	400.0	400.0	Beauty Salon
653082	475.0	475.0	Manufacturing
653048	625.0	625.0	Food Production/Sales
653060	200.0	200.0	Rickshaw
653088	400.0	400.0	Wholesale
653089	400.0	400.0	General Store
653062	400.0	400.0	Clothing Sales
653075	225.0	225.0	Poultry
653054	300.0	300.0	Rickshaw
653091	400.0	400.0	General Store
653052	875.0	875.0	Tailoring
653066	250.0	250.0	Sewing
653080	475.0	475.0	Beauty Salon

showing 1–20 of 671205

The dataset used for this project is released by Kiva which provides loans to low-income entrepreneurs and students. The dataset contains various variables listed below.

- id - a unique identifier for each loan sanctioned.
- funded_amount - amount that has been disbursed by Kiva to the field agent.
- loan_amount - amount that has been released to the borrower by the field agent.
- activity - low level category for which the loan has been issued.
- sector - high level category for which the loan has been issued.
- use - amount for which loan has been issued
- country_code - ISO country code of country in which loan was disbursed
- country - Full country name of country in which loan was disbursed
- region - Full region name within the country
- currency - The currency in which the loan was disbursed
- partner_id - ID of partner organization

- posted_time - the time at which the loan is posted on Kiva by the field agent
- disbursed_time - The time at which the loan is disbursed by the field agent to the borrower
- funded_time - The time at which the loan posted to Kiva gets funded by lenders completely
- term_in_months - The duration for which the loan was disbursed in months
- lender_count - The total number of lenders that contributed to this loan
- repayment_status - categorial variable for repayment status of the sanctioned loan.

Exploratory Data Analysis

```
In[]:= Dimensions[kivaloan]
Out[]= {671 205, 20}
```

The ***kivaloan*** dataset has 6,71205 rows and 20 columns.

Check if there are any duplicate **ids** in kivaloan dataset

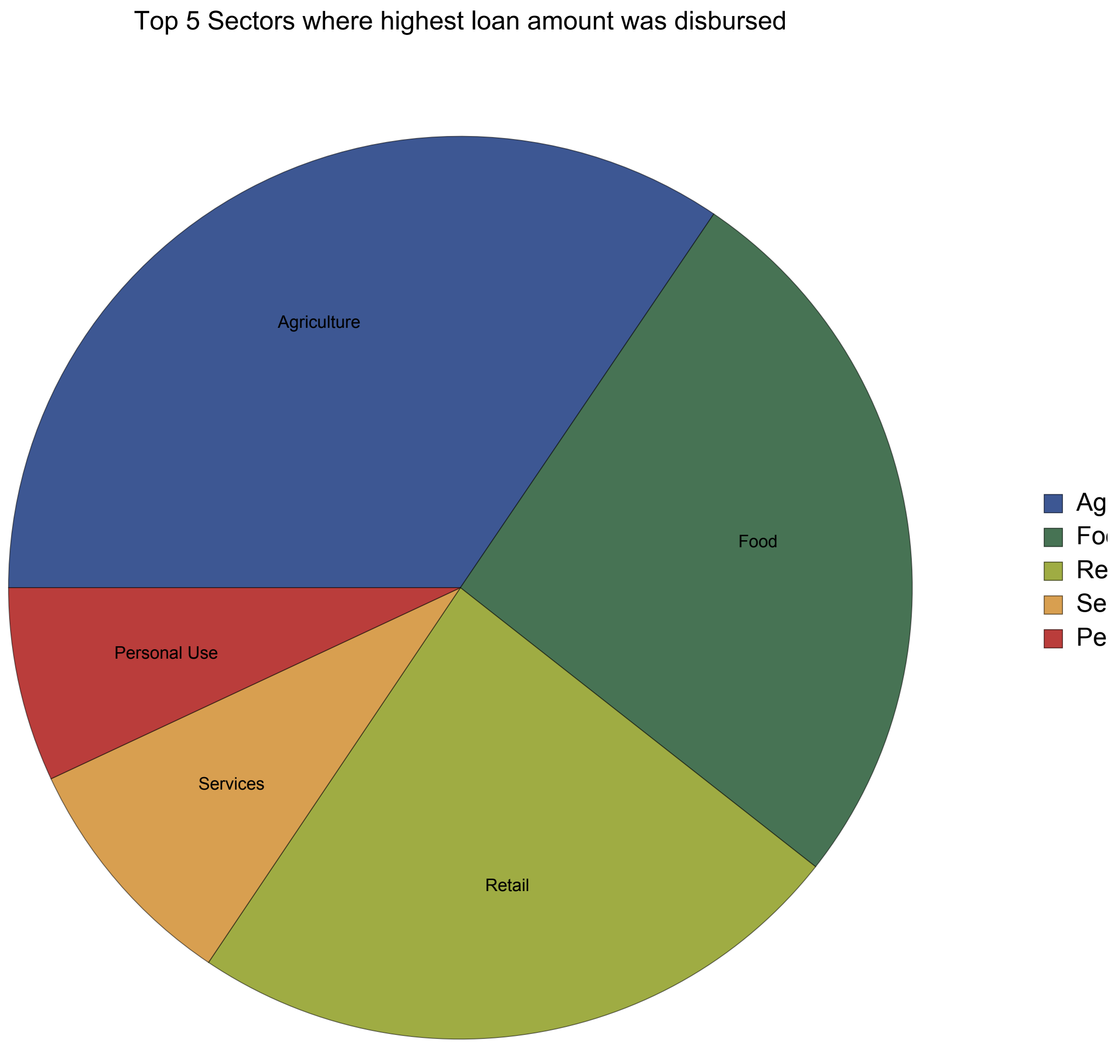
```
DuplicateFreeQ[kivaloan[[All, 1]]]
Out[]= True
```

There are no duplicate id entries in table.

Pie chart: Sector for which highest loan amount was disbursed

In[∘]:=
```
PieChart[Sort[Counts[kivaloan[All, "sector"]], Greater][1 ;; 5],
 ChartStyle → "DarkRainbow", ChartLabels → Automatic, ChartLegends → Automatic,
 PlotLabel → Style["Top 5 Sectors where highest loan amount was disbursed",
   FontSize → 13.5], ImageSize → Large]
```

Out[∘]=



Finding the highest number of lender count in the dataset

In[∘]:=
```
Sort[kivaloan[All, "lender_count" ], Greater][1 ;; 1]
```

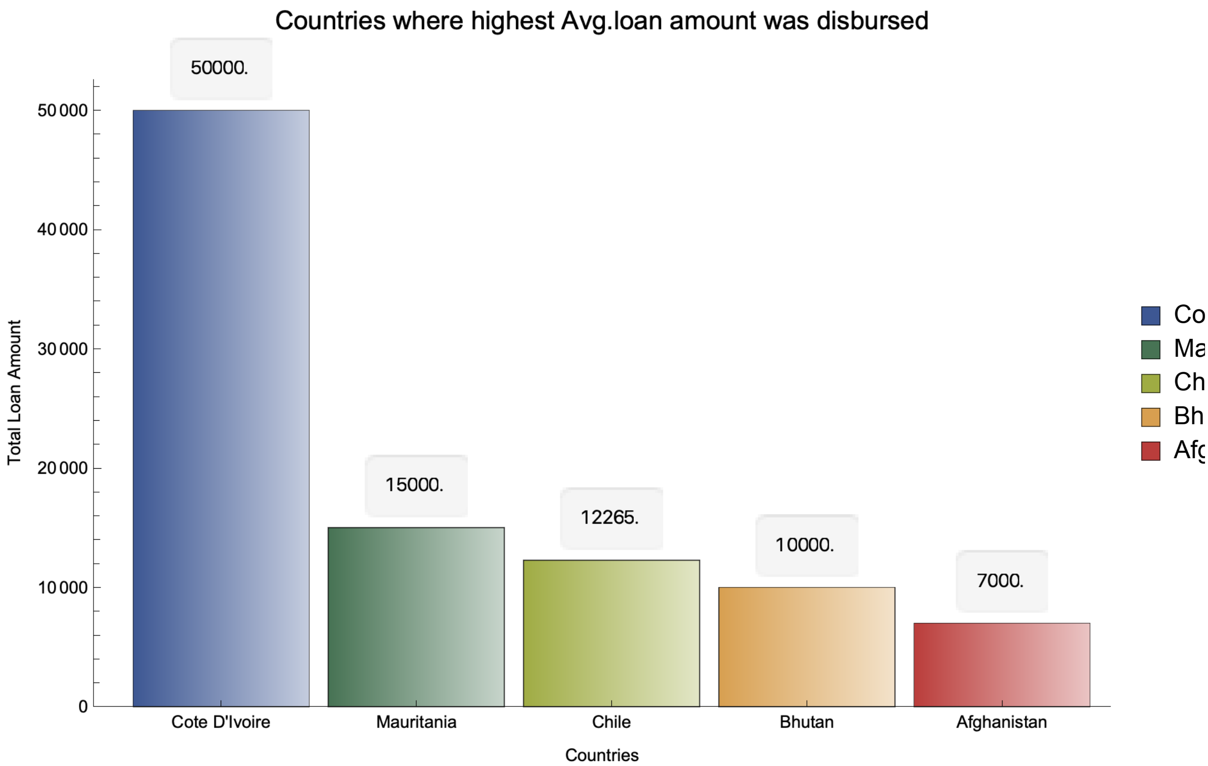
Out[∘]= 2986

The highest number of lender count in the dataset is 2986.

Bar Chart: Average loan amount disbursed among countries

In[•]:=
```
BarChart[
 Sort[kivaloan[GroupBy["country"], Mean, "loan_amount"], Greater][1 ;; 5],
 ChartStyle → "DarkRainbow", ChartLabels → Automatic, ChartLegends → Automatic,
 ChartElementFunction → "FadingRectangle", PlotLabel → Style[
   "Countries where highest Avg.loan amount was disbursed", FontSize → 13.5],
 LabelingFunction → (Placed[Panel[NumberForm[N@#1]], Above] &),
 FrameLabel → {{"Total Loan Amount", None}, {"Countries", None}},
 Frame → {{True, None}, {True, None}}, ImageSize → Large]
```

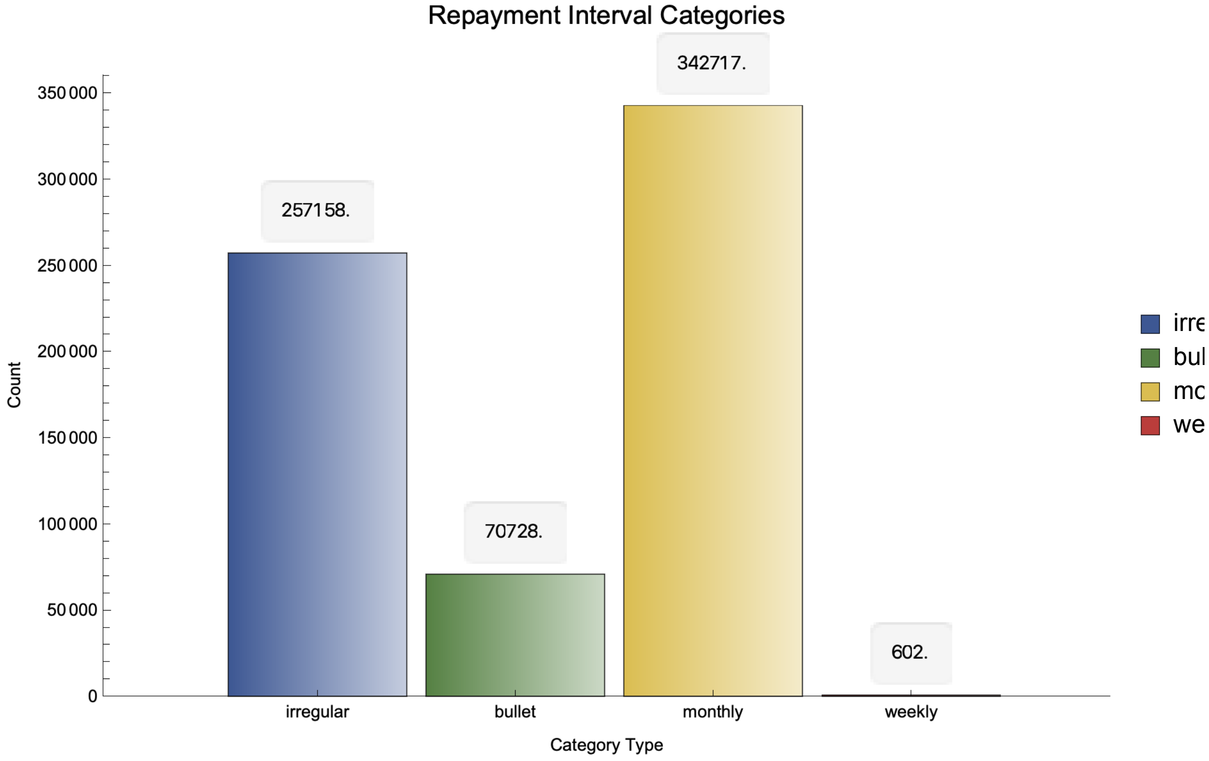
Out[•]=



Bar Chart: Repayment Interval vs Count

In[•]:=
```
BarChart[Counts[kivaloan[All, "repayment_interval"]],
 ChartLabels → Automatic, ChartStyle → "DarkRainbow",
 ChartLegends → Automatic, ChartElementFunction → "FadingRectangle",
 PlotLabel → Style["Repayment Interval Categories", FontSize → 13.5],
 LabelingFunction → (Placed[Panel[NumberForm[N@#1]], Above] &),
 FrameLabel → {{"Count", None}, {"Category Type", None}},
 Frame → {{True, None}, {True, None}}, ImageSize → Large]
```

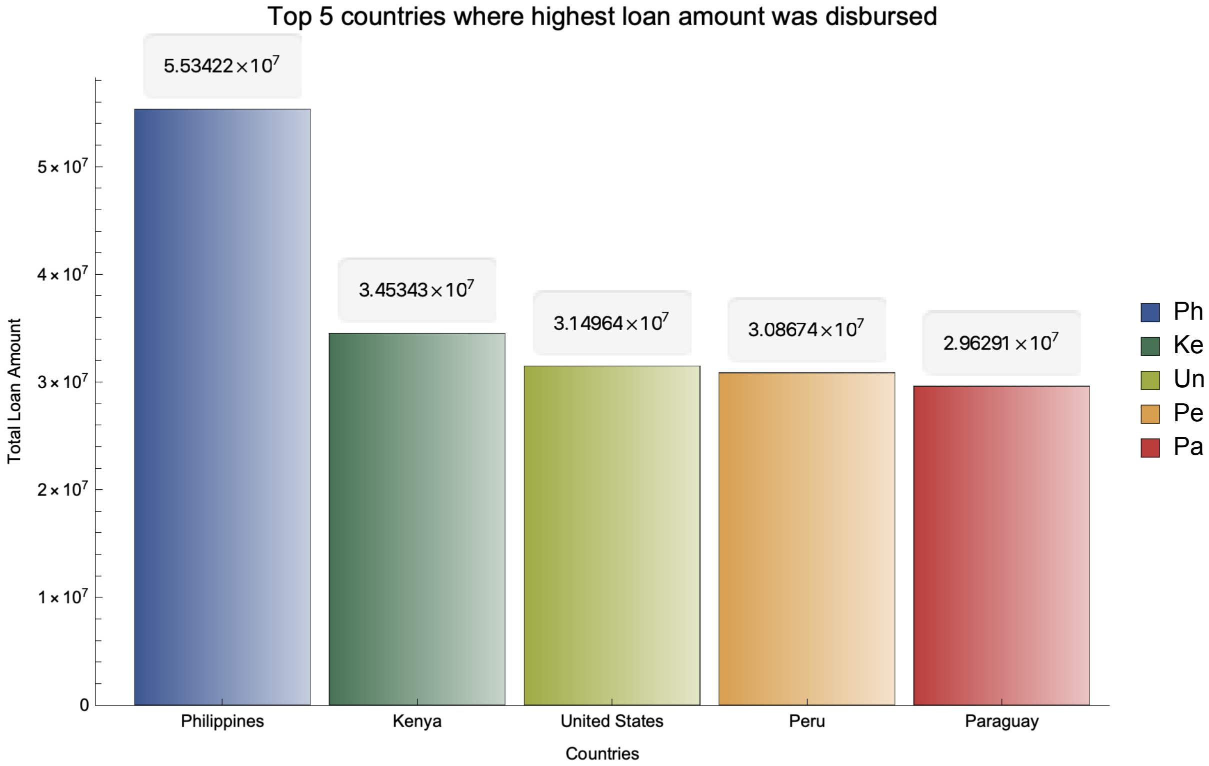
Out[•]=



Top 5 Countries where highest total loan amount was disbursed

In[∘]:=
```
BarChart[
 Sort[kivaloan[GroupBy["country"], Total, "loan_amount"], Greater][1 ;; 5],
 ChartStyle → "DarkRainbow", ChartLabels → Automatic, ChartLegends → Automatic,
 ChartElementFunction → "FadingRectangle", PlotLabel → Style[
   "Top 5 countries where highest loan amount was disbursed", FontSize → 13.5],
 LabelingFunction → (Placed[Panel[NumberForm[N@#1]], Above] &),
 FrameLabel → {{"Total Loan Amount", None}, {"Countries", None}},
 Frame → {{True, None}, {True, None}}, ImageSize → Large]
```

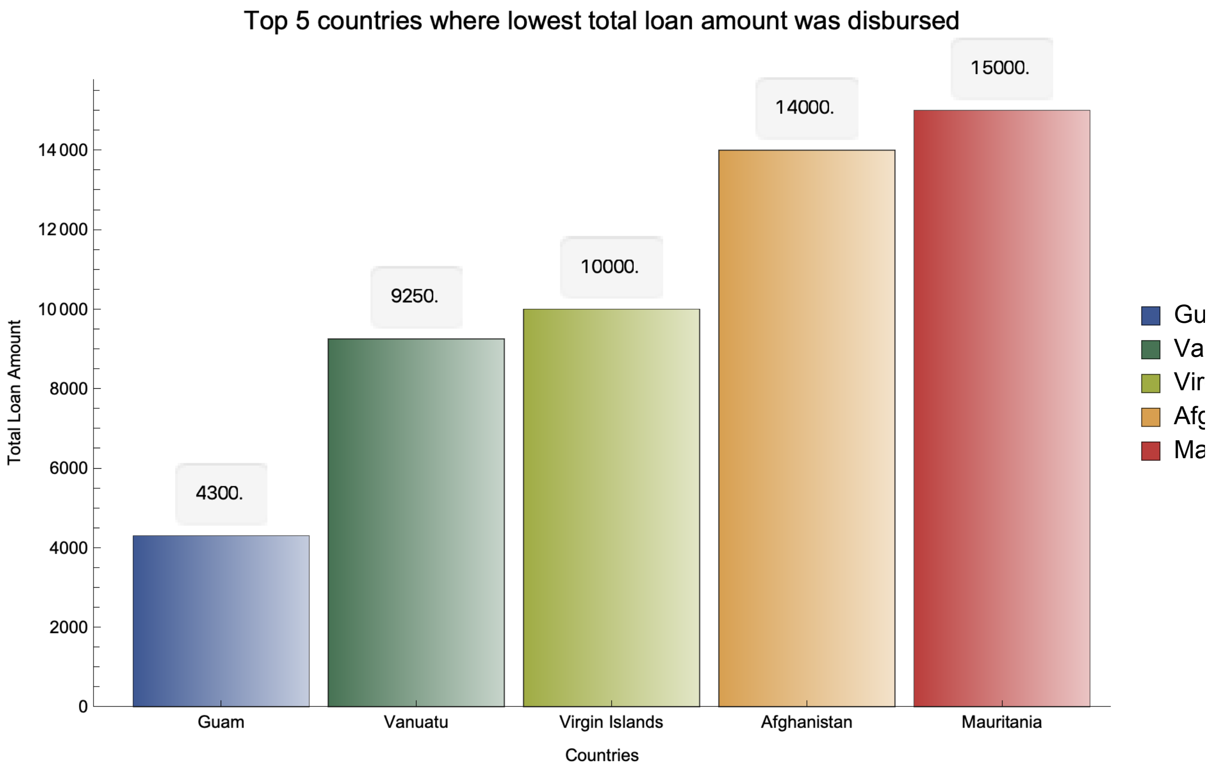
Out[∘]=



Countries where lowest loan amount was disbursed

In[∘]:=
```
BarChart[Sort[kivaloan[GroupBy["country"], Total, "loan_amount"]][1 ;; 5],
 ChartStyle → "DarkRainbow", ChartLabels → Automatic,
 ChartLegends → Automatic, ChartElementFunction → "FadingRectangle", PlotLabel →
  Style["Top 5 countries where lowest total loan amount was disbursed",
   FontSize → 13.5],
 LabelingFunction → (Placed[Panel[NumberForm[N@#1]], Above] &),
 FrameLabel → {{"Total Loan Amount", None}, {"Countries", None}},
 Frame → {{True, None}, {True, None}}, ImageSize → Large]
```

Out[∘]=

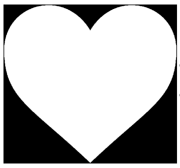


WordCloud generates the word cloud graphics with different sizes based on the multiplicity in given input data

```
In[•]:= WordCloud[WordCounts[ToString[kivaloan[All, "country"]]]]
```

Out[•]=

Country where highest number of loans/funds raised by Kiva was granted to Philippines followed by Kenya.

In[•]:= `WordCloud[kivaloan[All, "activity"],`  `]`

Out[•]=

Top Activities/Reason for which the loan was granted are General Store, Housing Expenses, Farming.

In[•]:=
```
gender = kivaloan[All, "borrower_genders"];
Total[StringCount[Normal[gender], "male"]];
Total[StringCount[Normal[gender], "female"]];
PieChart3D[{Total[StringCount[Normal[gender], "male"]],
  Total[StringCount[Normal[gender], "female"]]}, ChartStyle → "DarkRainbow",
 ChartLabels → Placed[{"Male", "Female"}, "RadialOuter"]]
```

Out[•]=

There are total of 13,46,212 individual male borrowers and 10,71,308 female borrowers.

Machine Learning - Classification

Predicting Labelled Data

In[•]:=
```
kivaloan = kivaloan[1 ;; 400 000];
train = {};
test = {};
For[i = 1, i ≤ Length[kivaloan], i++,
 If[RandomInteger[{1, Length[kivaloan]}] < Length[kivaloan] 70 / 100,
  AppendTo[train, Normal[kivaloan[i, All]]],
  AppendTo[test, Normal[kivaloan[i, All]]]]]
train = Dataset[train];
test = Dataset[test];
```

Dropping the columns that will not be included in model

In[•]:=
```
train = Dataset[Drop[train[1 ;; Length[train], Range[1, 19]]]];
test = Dataset[Drop[test[1 ;; Length[test], Range[1, 19]]]];
```

In[•]:=
```
Clear[trainsetFeatures, testsetFeatures]
train = Drop[train[1 ;; Length[train], Range[1, 19]]];
trainsetFeatures = train[1 ;; Length[train]];
trainsetFinal =
  Flatten[Normal@trainsetFeatures[1 ;; Length[train], {Most@# → Last@#} &], 1];
testsetFeatures = test[1 ;; Length[test]];
testsetFinal =
  Flatten[Normal@testsetFeatures[1 ;; Length[test], {Most@# → Last@#} &], 1];
```

Random Forest

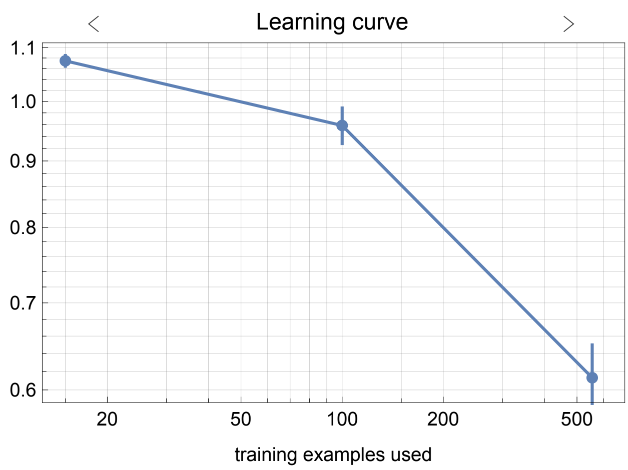
In[∘]:=
```
Clear[classifierMeasurements, algoRandomForest]
algoRandomForest = Classify[trainsetFinal, Method → "RandomForest"]
ClassifierInformation[algoRandomForest]
classifierMeasurements =
 ClassifierMeasurements[algoRandomForest, testsetFinal]
classifierMeasurements /@ {"Accuracy", "Error"} // TableForm
```

Out[∘]= ClassifierFunction[Input type: Mixed (number: 18) Classes: bullet, irregular, monthly]

Out[∘]=

Classifier information

Data type	Mixed (number: 18)
Classes	bullet, irregular, monthly
Accuracy	(91. ± 4.)%
Method	RandomForest
Single evaluation time	15.9 ms/example
Batch evaluation speed	1.74 examples/ms
Loss	0.613 ± 0.037
Model memory	686. kB
Training examples used	694 examples
Training time	1.15 s



Out[∘]= ClassifierMeasurementsObject[Classifier: RandomForest Number of test examples: 306]

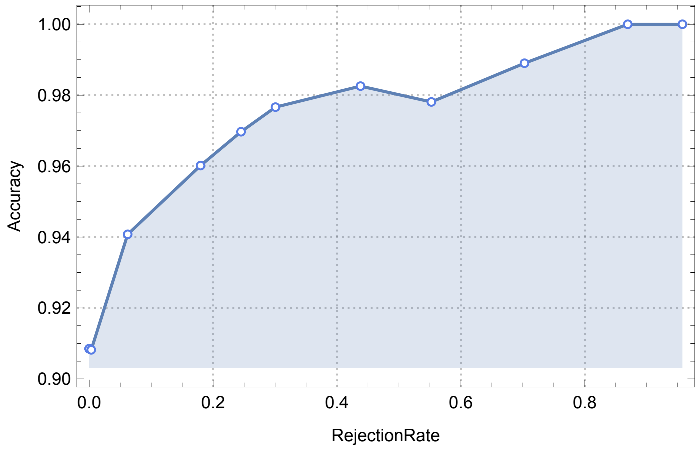
Out[∘]//TableForm=
```
0.908497
0.0915033
```

The accuracy of the Random Forest Model is 91% and error produced by the model is 0.09%

Now lets plot the Accuracy Rejection Model

In[•]:=
```
classifierMeasurements["AccuracyRejectionPlot"]
```

Out[•]=



Classifying the labelled data. We are here trying to classify the repayment interval. The repayment interval can be of 3 types: **Weekly, bullet, Irregular, monthly**.

In[•]:=
```
algoRandomForest[<|"id" → 653 051, "funded_amount" → 300.`,
  "loan_amount" → 300.`, "activity" → "Fruits & Vegetables", "sector" → "Food",
  "use" → "To buy seasonal, fresh fruits to sell. ", "country_code" → "PK",
  "country" → "Pakistan", "region" → "Lahore", "currency" → "PKR",
  "partner_id" → 247.`, "posted_time" → "2014-01-01 06:12:39+00:00",
  "disbursed_time" → "2013-12-17 08:00:00+00:00",
  "funded_time" → "2014-01-02 10:06:32+00:00", "term_in_months" → 12.`,
  "lender_count" → 12, "tags" → "", "borrower_genders" → "female"|>]
```

Out[•]=
```
irregular
```

The repayment interval classified above is “Irregular” for the given user input for built Random Forest model.

Logistic Regression

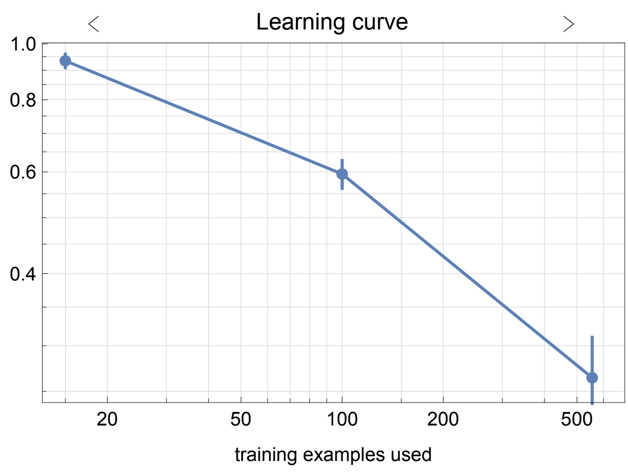
In[•]:=
```
Clear[classifierMeasurements, algoLogisticRegression]
algoLogisticRegression = Classify[trainsetFinal, Method → "LogisticRegression"]
ClassifierInformation[algoLogisticRegression]
classifierMeasurements =
 ClassifierMeasurements[algoLogisticRegression, testsetFinal]
classifierMeasurements /@ {"Accuracy", "Error"} // TableForm
```

Out[•]= ClassifierFunction[Input type: Mixed (number: 18) Classes: bullet, irregular, monthly]

Out[•]=

Classifier information

Data type	Mixed (number: 18)
Classes	bullet, irregular, monthly
Accuracy	(94.4 ± 2.9)%
Method	LogisticRegression
Single evaluation time	16.9 ms/example
Batch evaluation speed	1.62 examples/ms
Loss	0.264 ± 0.046
Model memory	666. kB
Training examples used	694 examples
Training time	3.13 s



Out[•]= ClassifierMeasurementsObject[Classifier: LogisticRegression Number of test examples: 306]

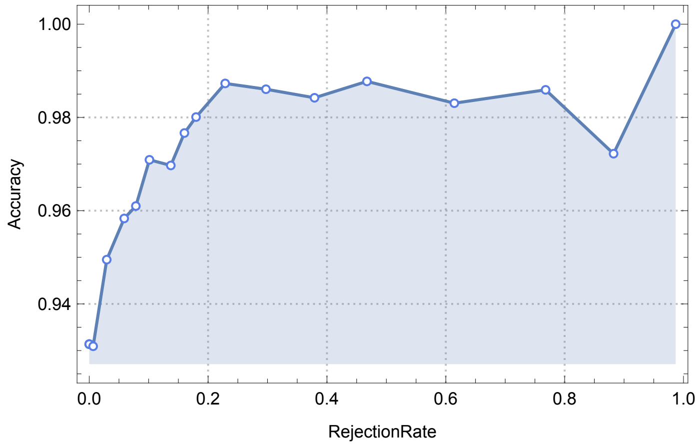
Out[•]//TableForm=
```
0.931373
0.0686275
```

The accuracy of the Random Forest Model is 93% and error produced by the model is 0.06%

Now lets plot the Accuracy Rejection Model

In[•]:=
```
classifierMeasurements["AccuracyRejectionPlot"]
```

Out[•]=



Classifying the labelled data on the trained Logistic Regression model.

In[•]:=
```
algoLogisticRegression[<|"id" → 653 089, "funded_amount" → 400.`,
  "loan_amount" → 400.`, "activity" → "General Store", "sector" → "Retail",
  "use" → "to buy stock of rice, sugar and flour .", "country_code" → "PK",
  "country" → "Pakistan", "region" → "Faisalabad", "currency" → "PKR",
  "partner_id" → 245.`, "posted_time" → "2014-01-01 12:04:57+00:00",
  "disbursed_time" → "2013-12-24 08:00:00+00:00",
  "funded_time" → "2014-01-08 00:35:14+00:00",
  "term_in_months" → 14.`, "lender_count" → 16,
  "tags" → "#Repeat Borrower, #Woman Owned Biz", "borrower_genders" → "female"|>]
```

Out[•]=
```
monthly
```

Neural Network

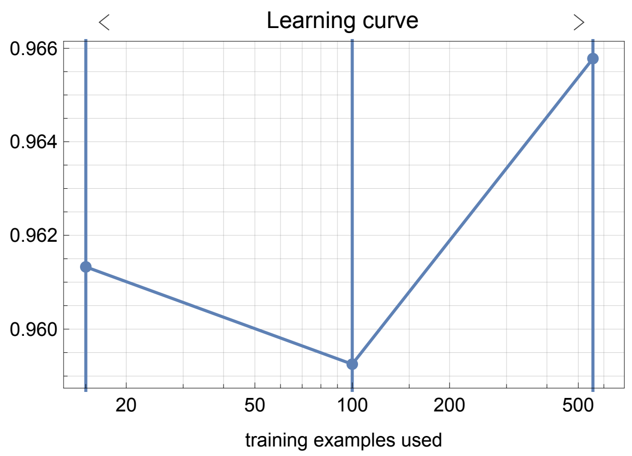
In[∘]:=
```
Clear[algoNeuralNetwork, classifierMeasurements]
algoNeuralNetwork = Classify[trainsetFinal, Method → "NeuralNetwork"]
ClassifierInformation[algoNeuralNetwork]
classifierMeasurements =
 ClassifierMeasurements[algoNeuralNetwork, testsetFinal]
classifierMeasurements /@ {"Accuracy", "Error"} // TableForm
```

Out[∘]= ClassifierFunction[Input type: Mixed (number: 18) Classes: bullet, irregular, monthly]

Out[∘]=

Classifier information

Data type	Mixed (number: 18)
Classes	bullet, irregular, monthly
Accuracy	(53. ± 5.)%
Method	NeuralNetwork
Single evaluation time	21.2 ms/example
Batch evaluation speed	961. examples/s
Loss	0.959 ± 0.063
Model memory	878. kB
Training examples used	694 examples
Training time	9.04 s



Out[∘]= ClassifierMeasurementsObject[Classifier: NeuralNetwork Number of test examples: 306]

Data not in notebook; Store now »

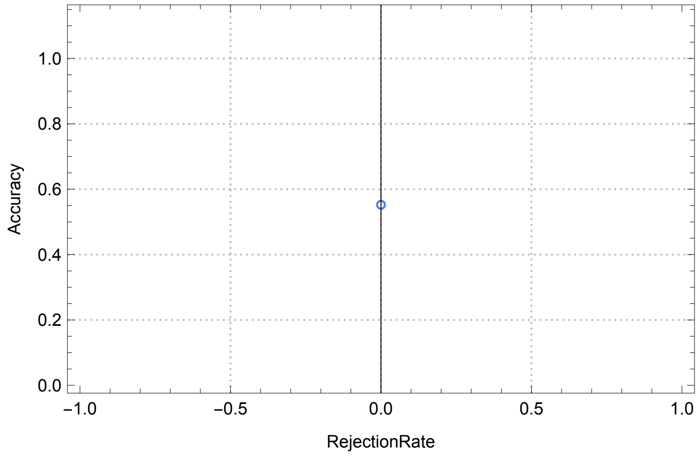
Out[∘]//TableForm=
```
0.552288
0.447712
```

The accuracy of the Neural Network Model is 55% and error produced by the model is 44%. This is not the good model for kiva loan data as the accuracy is less.

Plot for the Accuracy Rejection Model

In[∘]:=
```
classifierMeasurements["AccuracyRejectionPlot"]
```

Out[∘]=



Classifying the labelled trained data on the Logistic Neural Network model.

In[∘]:=
```
algoNeuralNetwork[<|"id" → 653 089, "funded_amount" → 400.`,
  "loan_amount" → 400.`, "activity" → "General Store", "sector" → "Retail",
  "use" → "to buy stock of rice, sugar and flour .", "country_code" → "PK",
  "country" → "Pakistan", "region" → "Faisalabad", "currency" → "PKR",
  "partner_id" → 245.`, "posted_time" → "2014-01-01 12:04:57+00:00",
  "disbursed_time" → "2013-12-24 08:00:00+00:00",
  "funded_time" → "2014-01-08 00:35:14+00:00",
  "term_in_months" → 14.`, "lender_count" → 16,
  "tags" → "#Repeat Borrower, #Woman Owned Biz", "borrower_genders" → "female"|>]
```

Out[∘]=
```
monthly
```

Nearest Neighbors

In[∘]:=
```
Clear[classifierMeasurements, algoNearestNeighbors]
algoNearestNeighbors = Classify[trainsetFinal, Method → "NearestNeighbors"]
ClassifierInformation[algoNearestNeighbors]
classifierMeasurements =
 ClassifierMeasurements[algoNearestNeighbors, testsetFinal]
classifierMeasurements /@ {"Accuracy", "Error"} // TableForm
```

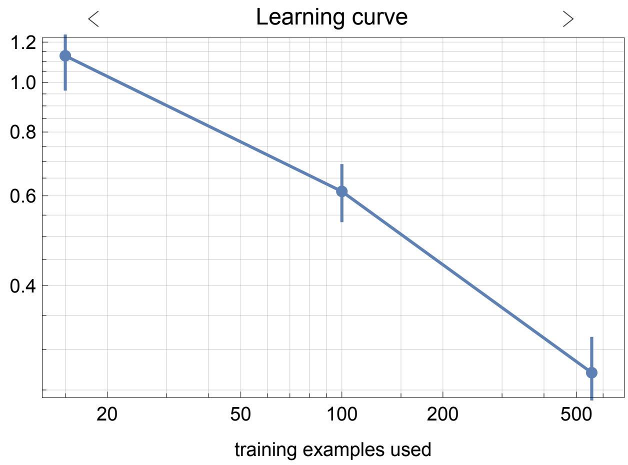
Out[∘]= ClassifierFunction[Input type: Mixed (number: 18) Classes: bullet, irregular, monthly]

Data not in notebook; Store now »

Out[∘]=

Classifier information

Data type	Mixed (number: 18)
Classes	bullet, irregular, monthly
Accuracy	(96.1 ± 2.6)%
Method	NearestNeighbors
Single evaluation time	13.4 ms/example
Batch evaluation speed	2.07 examples/ms
Loss	0.270 ± 0.045
Model memory	7.09 MB
Training examples used	694 examples
Training time	975. ms



Out[∘]= ClassifierMeasurementsObject[Classifier: NearestNeighbors Number of test examples: 306]

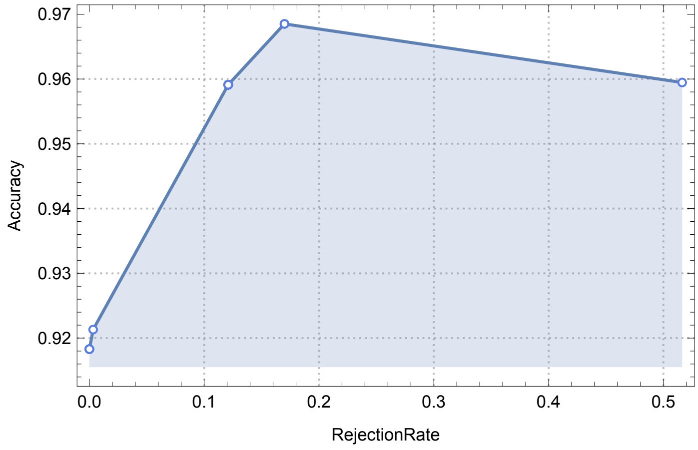
Data not in notebook; Store now »

Out[∘]//TableForm=
```
0.918301
0.0816993
```

The accuracy of the Nearest Neighbors Model is 92% and error produced by the model is 8%.

In[∘]:=
```
classifierMeasurements["AccuracyRejectionPlot"]
```

Out[∘]=



Classifying the labelled trained data on the Nearest Neighbors model.

In[∘]:=
```
algoNearestNeighbors[<|"id" → 653 208, "funded_amount" → 500.`,
  "loan_amount" → 500.`, "activity" → "Cereals", "sector" → "Food",
  "use" → "to buy cereals to increase his stock", "country_code" → "KE",
  "country" → "Kenya", "region" → "Nanyuki", "currency" → "KES",
  "partner_id" → 203.`, "posted_time" → "2014-01-02 08:03:33+00:00",
  "disbursed_time" → "2013-12-11 08:00:00+00:00",
  "funded_time" → "2014-01-29 16:09:50+00:00",
  "term_in_months" → 14.`, "lender_count" → 20,
  "tags" → "#Elderly, #Repeat Borrower, user_favorite, user_favorite",
  "borrower_genders" → "male"|>]
```

Out[∘]=
```
irregular
```

Geographic Plotting

In[∘]:=
```
dhsmpi =
  Import["/Users/vipinragashetti/Vipin/Workspace/UCD/semester-I/Mathematica
     for Research/Project/myproject/dhs_mpi_loan.csv"];
header = dhsmpi[[1]];
data = dhsmpi[[2 ;;]];
dhsmpi = Thread[header → #] & /@ data // Map[Association];
dhsmpi  = Dataset[dhsmpi];
```

Converting the latitude and longitude from degrees to radians.

In[•]:=
```
dhsmpi = dhsmpi[All, Append[#, "latradian" → N[0.017 * (#"lat"), 5]] &];
dhsmpi = dhsmpi[All, Append[#, "lonradian" → N[0.017 * (#"lon"), 5]] &];
dhsmpi = dhsmpi[All, Append[#, "latlon" → {#"latradian", #"lonradian"}] &];
dhsmpi[[1 ;;]]
```

Out[•]=

	DHS(	Partr	Field	sectc	Loan	Loan
1	366	154	FundaciÍ_n Mario Santo Domingo (FMSD)	Other	a1050000002ZOr8	Control Grou
2	366	154	FundaciÍ_n Mario Santo Domingo (FMSD)	Other	a1050000006Tm5J	Single moth
3	366	154	FundaciÍ_n Mario Santo Domingo (FMSD)	Other	a1050000000wf0w	General
4	366	154	FundaciÍ_n Mario Santo Domingo (FMSD)	Other	a1050000002ZOqt	Flexible loar
5	366	154	FundaciÍ_n Mario Santo Domingo (FMSD)	Other	a1050000006Tm4k	Unbanked
6	366	154	FundaciÍ_n Mario Santo Domingo (FMSD)	Other	a1050000002ZOqz	Flexible loar
7	366	154	FundaciÍ_n Mario Santo Domingo (FMSD)	Other	a1050000006Tm59	Youth Entre
8	443	154	FundaciÍ_n Mario Santo Domingo (FMSD)	Other	a1050000006Tm59	Youth Entre
9	443	154	FundaciÍ_n Mario Santo Domingo (FMSD)	Other	a1050000002ZOqz	Flexible loar
10	443	154	FundaciÍ_n Mario Santo Domingo (FMSD)	Other	a1050000000wf0w	General
11	443	154	FundaciÍ_n Mario Santo Domingo (FMSD)	Other	a1050000002ZOqt	Flexible loar
12	443	154	FundaciÍ_n Mario Santo Domingo (FMSD)	Other	a1050000000wf0w	General
13	443	154	FundaciÍ_n Mario Santo Domingo (FMSD)	Other	a1050000002ZOqt	Flexible loar
14	443	154	FundaciÍ_n Mario Santo Domingo (FMSD)	Other	a1050000002ZOr8	Control Grou
15	443	154	FundaciÍ_n Mario Santo Domingo (FMSD)	Other	a1050000006Tm4k	Unbanked
16	443	154	FundaciÍ_n Mario Santo Domingo (FMSD)	Other	a1050000006Tm5J	Single moth
17	443	154	FundaciÍ_n Mario Santo Domingo (FMSD)	Other	a1050000000wf0w	General
18	443	154	FundaciÍ_n Mario Santo Domingo (FMSD)	Other	a1050000002ZOqt	Flexible loar
19	443	154	FundaciÍ_n Mario Santo Domingo (FMSD)	Other	a1050000002ZOr8	Control Grou
20	443	154	FundaciÍ_n Mario Santo Domingo (FMSD)	Other	a1050000002ZOr8	Control Grou

showing 1–20 of 5266

Plotting the points on the Interactive map where the loans was distributed by Kiva

In[•]:=
```
f[x_, y_] := ({x[[#]], y[[#]]}) & /@ Range[Min[Length[x], Length[y]]];
coord = f[dhsmpi[All, "lat"], dhsmpi[All, "lon"]];
```

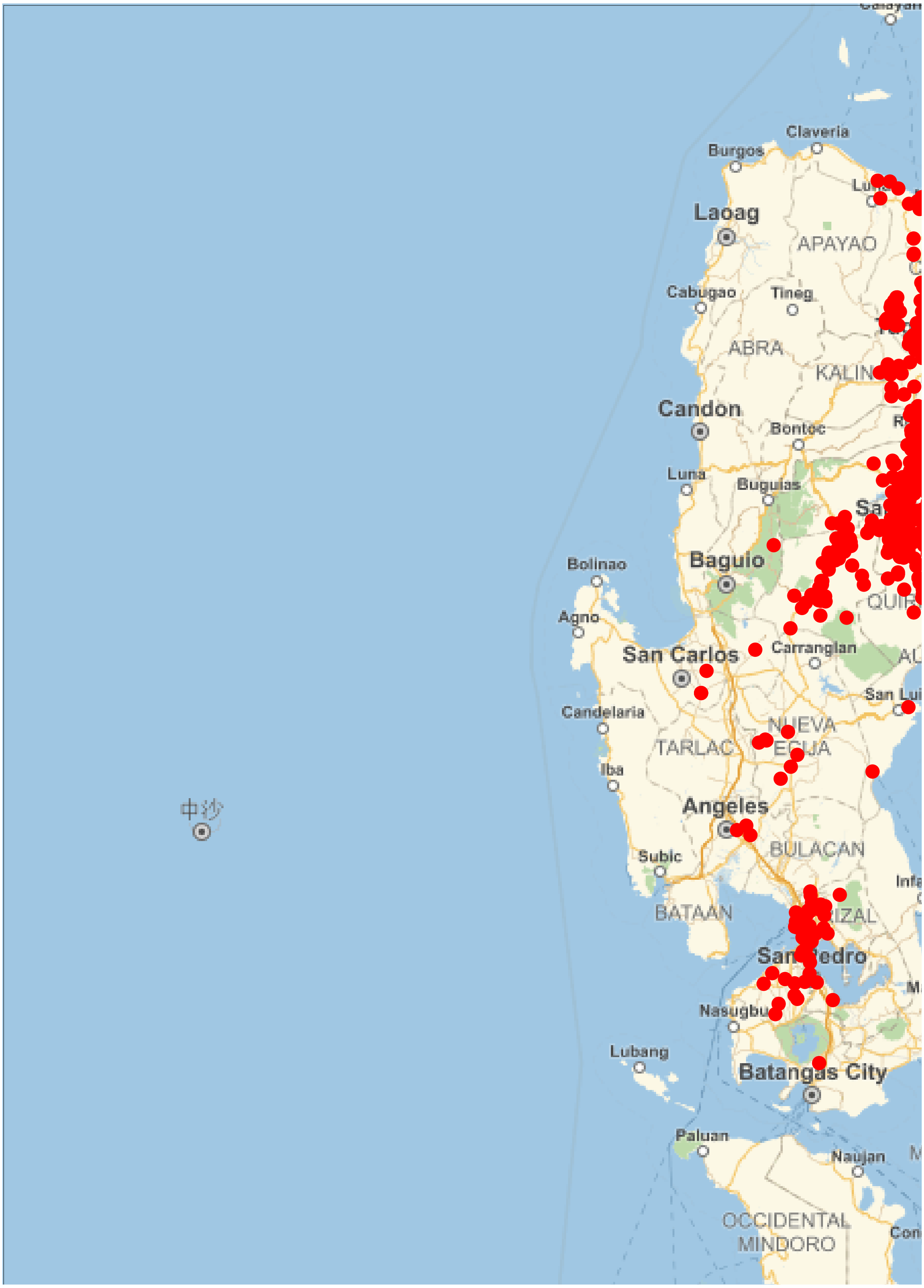
In[•]:=
```
DynamicGeoGraphics[{Orange, PointSize[Large], Point@GeoPosition@coord},
  GeoRange → "World", GeoProjection → "Robinson"]
```

Out[•]=

Plotting the Interactive Map of Philippines where highest number of loans were distributed.

[Map requires Internet connection to get loaded]

In[•]:=
```
DynamicGeoGraphics[{Red, PointSize[Large], Point@GeoPosition@coord},
 GeoRange → Entity["Country", "Philippines"],
 GeoResolution → Quantity[1, "Kilometers"], GridLines → Automatic]
```



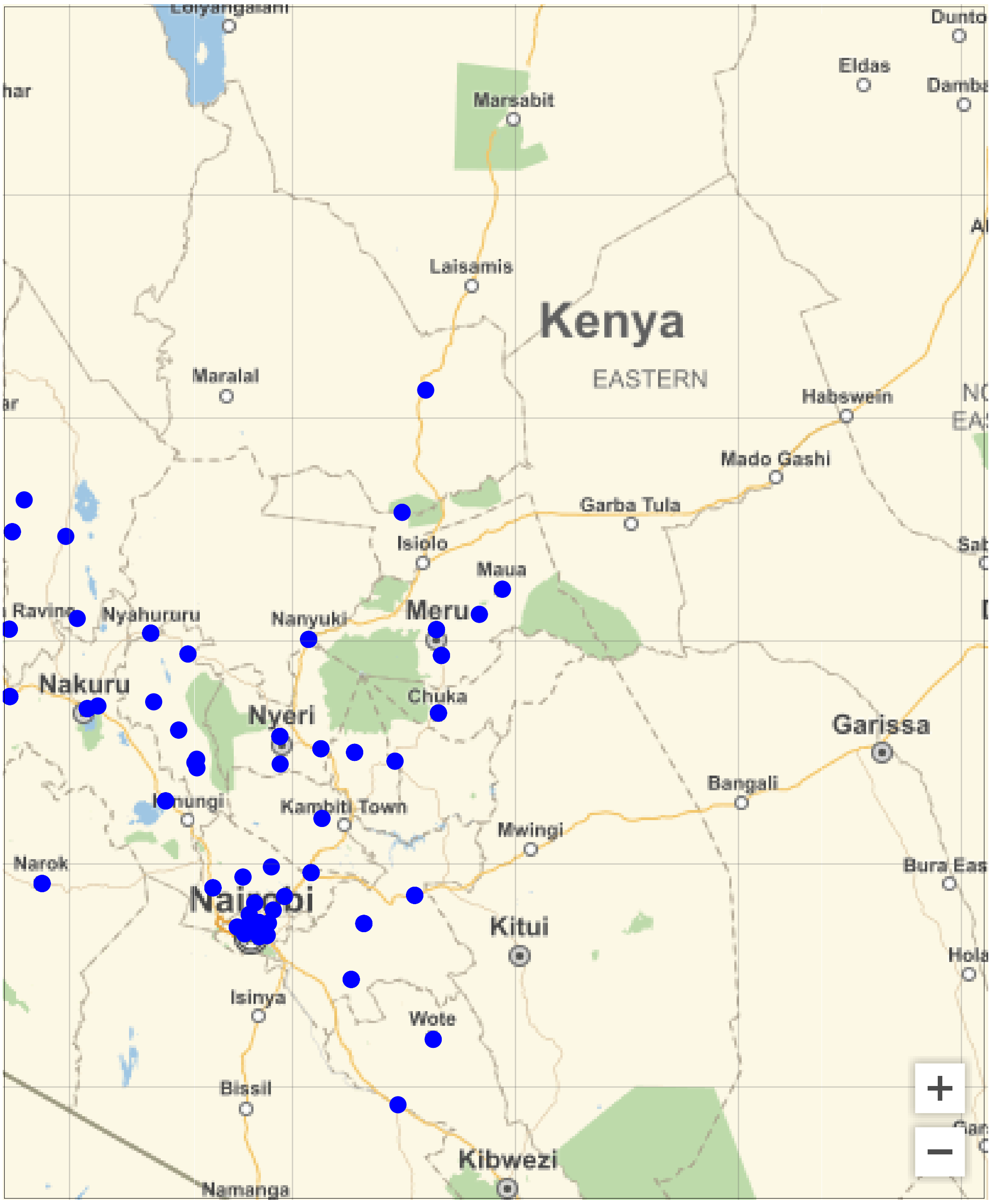
Out[ ]=


Roxas
San Jose
Coron
Linapacan
El Nido
Agutaya
Taytay
Cuyo
Dumaran
Roxas
Puerto Princesa
Cagayancillo
Narra
Quezon
Rizal
Bataraza
Balabac
Bilang Bilangan
Mapun
Kudat
Pinatabaan
Pangutaran
Omar
SULU
Kg. Lidong
Sandakan
Siasi
SABAH
Tongod
TAWI-

Plotting the Interactive map for Kenya where loans were distributed [Map requires Internet connection to get loaded]

In[*]:=
```
DynamicGeoGraphics[{Blue, PointSize[Large], Point@GeoPosition@coord},
 GeoRange → Entity["Country", "Kenya"],
 GeoProjection → "Robinson", GeoGridLines → Automatic]
```

Out[*]=



Machine Learning - Prediction

Predicting Unlabelled Data

In dhs_mpi_loan.csv, the countries are grouped into clusters and contains the geographic locations like latitude and longitude where the loan was disbursed. We will try to build the model using these geographic parameters and try to predict the cluster id. This data is provided my 'The Demographic and Health Surveys Program' (DHS) which is responsible for collecting and disseminating accurate, nationally representative data on health and population in developing countries .

We will be using the predict function which is used to predict/classify the unlabelled continuous data.

In[∘]:=
```
traindata = {};
For[i = 1, i ≤ Length[dhsmpi], i++, list = AppendTo[traindata,
   Normal[dhsmpi[i, "latlon"]] → Normal[dhsmpi[i, "DHSCLUST"]]]]
```

Gaussian Process

In[∘]:=
```
predictGaussianProcess = Predict[traindata, Method → "GaussianProcess"]
```

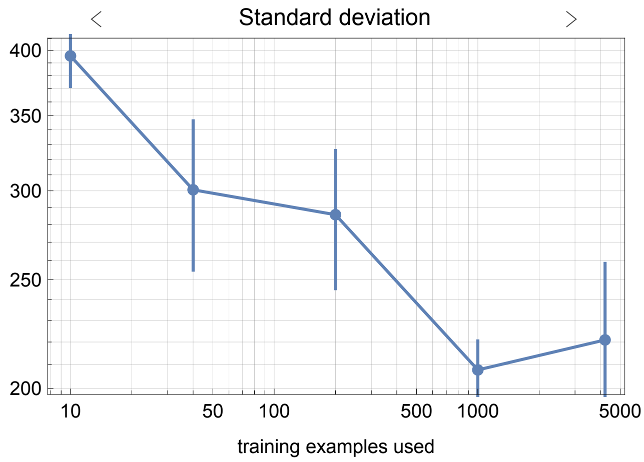
Out[∘]=
```
PredictorFunction[ Input type: NumericalVector (length: 2)
                   Method: GaussianProcess
                   Data not in notebook; Store now » ]
```

In[∘]:=
```
Information[predictGaussianProcess]
```

Out[∘]=

Predictor information

Data type	NumericalVector (length: 2)
Standard deviation	208. ± 13.
Method	GaussianProcess
Single evaluation time	33.4 ms/example
Batch evaluation speed	396. examples/s
Loss	8.08 ± 0.86
Model memory	222. MB
Training examples used	5266 examples
Training time	5 min 21 s



Predicting the Cluster Id when the latitude is 4.19158 and longitude is -1.313 using Linear Regression model

In[∘]:=
```
predictGaussianProcess[{4.19158, -1.313}]
```

Out[∘]=
```
572.933
```

Linear Regression

In[∘]:=
```
predictLinearRegression = Predict[traindata, Method → "LinearRegression"]
```

Out[∘]=
```
PredictorFunction[ Input type: NumericalVector (length: 2)
                   Method: LinearRegression ]
```

In[•]:=
```
Information[predictLinearRegression]
```

Out[•]=

Predictor information

Data type	NumericalVector (length: 2)
Standard deviation	383. ± 28.
Method	LinearRegression
Single evaluation time	1.57 ms/example
Batch evaluation speed	265. examples/ms
Loss	7.42 ± 0.047
Model memory	311. kB
Training examples used	5266 examples
Training time	4.26 s

Predicting the Cluster Id when the latitude is 0.19058 and longitude is -1.30563 using Linear Regression model

In[•]:=
```
predictLinearRegression[{0.19058, -1.30563}]
```

Out[•]=
```
1395.44
```

Random Forest

In[•]:=
```
predictRandomForest = Predict[traindata, Method → "RandomForest"]
```

Out[•]=
```
PredictorFunction[ Input type: NumericalVector (length: 2)
Method: RandomForest ]
```

In[∘]:=
```
Information[predictRandomForest]
```

Out[∘]=

Predictor information

Data type	NumericalVector (length: 2)
Standard deviation	236. ± 10.
Method	RandomForest
Single evaluation time	3.78 ms/example
Batch evaluation speed	36.2 examples/ms
Loss	6.77 ± 0.050
Model memory	437. kB
Training examples used	5266 examples
Training time	893. ms

Predicting the Cluster Id when the latitude is 10.1801 and longitude is -1.401 using Random Forest model

In[∘]:=
```
predictRandomForest[{10.1801, -1.401}]
```

Out[∘]= 754.799

Nearest Neighbors

In[∘]:=
```
predictNearestNeighbors = Predict[traindata, Method → "NearestNeighbors"]
```

Out[∘]= PredictorFunction[Input type: NumericalVector (length: 2) Method: NearestNeighbors]

In[•]:=
```
Information[predictNearestNeighbors]
```

Predictor information

Data type	NumericalVector (length: 2)
Standard deviation	175. ± 21.
Method	NearestNeighbors
Single evaluation time	1.75 ms/example
Batch evaluation speed	67.5 examples/ms
Loss	5.13 ± 0.055
Model memory	225. kB
Training examples used	5266 examples
Training time	763. ms

Out[•]=

Predicting the Cluster Id when the latitude is 11.1791 and longitude is -1.234 using Nearest Neighbors model

In[•]:=
```
predictNearestNeighbors[{11.1791, -1.234}]
```

Out[•]= 291.

Neural Network

In[•]:=
```
predictNeuralNetwork = Predict[traindata, Method → "NeuralNetwork"]
```

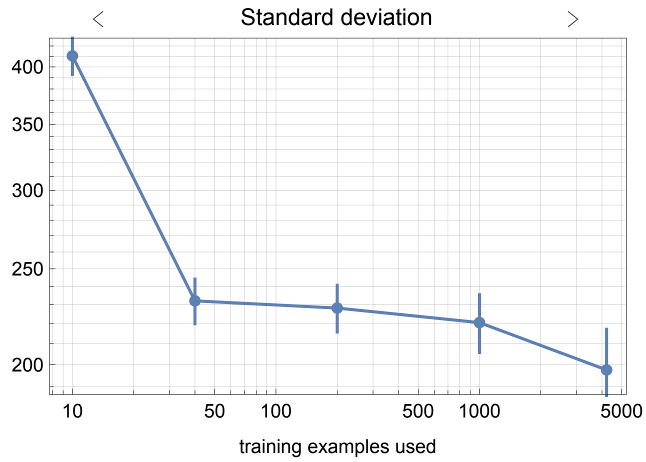
Out[•]= PredictorFunction[Input type: NumericalVector (length: 2) Method: NeuralNetwork]

In[ ]:=
```
Information[predictNeuralNetwork]
```

Out[ ]=

Predictor information

Data type	NumericalVector (length: 2)
Standard deviation	198. ± 20.
Method	NeuralNetwork
Single evaluation time	2.26 ms/example
Batch evaluation speed	45.6 examples/ms
Loss	6.70 ± 0.076
Model memory	422. kB
Training examples used	5266 examples
Training time	1 min 26 s



Predicting the Cluster Id when the latitude is 7.234 and longitude is -0.173 using Nearest Neighbors model

In[ ]:=
```
predictNeuralNetwork[{7.234, -0.173}]
```

Out[ ]=
```
6329.1
```

Conclusion

Exploratory Data Analysis Summary

- The country where highest amount of kiva loans was disbursed is *Philippines* followed by *Kenya* and *United States*.
- Large number of people are *regular/monthly* in the loan repayment. We also notice from the bar chart that there are significant people who are *irregular* in repaying the loan.
- Highest number of loans was disbursed for *Agriculture* sector followed by *food* and *retail.*
- The country where lowest amount of loan was disbursed was *Guam*.
- The country where with highest average loan amount is *Cote D’Ivoire*.

Machine Learning- Training, Classification and Prediction

Classification is used to classify the labelled data. Here were are trying to classify the repayment interval on the data. I have selected the first 4 lakhs records since mathematica software was crashing intermittently and was taking more time to build models.

Here the data is divided into train and test subset and various Machine Learning techniques are applied on the train data and the model is tested using test data. We notice from the above models that Accuracy of classification is highest for Nearest Neighbors and Logistic Regression. These models are best models when you are trying to predict the labelled/discrete data. Neural Network performed bad for this dataset and is more suitable for very large and continuous type of response variable.

Prediction technique is used to predict unlabelled/continuous data. We have used another dataset provided by DHS (Demographic and Health Surveys). Different countries together form a cluster and have a cluster id. We are trying to predict the cluster id when the latitude and longitude is provided as input to the model.

We have built the different models and predicted the cluster id from the trained model.

We have gained so many outcomes and insights from the Kiva crowd funded loan platform. Machine Learning and Exploratory Data Analysis can be performed in Mathematica software with ease. Machine Learning techniques like classification and prediction can be performed with a single command even though it takes some time for processing.

In this project, I have learned how to analyse, build models, classify and predict the data in Mathematica, in addition to its computation capabilities.

Mathematica is a user friendly application/software for Data Analysis and Machine Learning.