Communities and crime

Prediction of violent crime in the USA

Marie Lontsie Zanmene Yanis Bosch

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Outline

1. The dataset
2. Preprocessing
3. Correlation analysis
4. Regression
5. Performance analysis
6. Conclusion

The dataset

- Data sources:
  - Socio-economic data from the 1990 US Census
  - Law enforcement data from the 1990 US LEMAS survey
  - Crime data from the 1995 FBI UCR
- Creator: Michael Redmond, La Salle University, Philadelphia
- Date: 13th July, 2009

The dataset

- Size: 1994 rows, 128 columns
- Example attributes: police officers per 100K population, median rent,...
- Goal: Prediction of violent crime in the USA

The dataset

- As in most countries, violent crime is driven by socio-economic factors
- There seems to be a strong link between income inequality and crime
- Does our data confirm this?
- Which of these factors are of the highest importance?

Preprocessing

- Before studying these correlations we must make sure our data is clean
- The values are already normalised, we must thus turn our attention to missing values

Preprocessing

Column Name	Missing values	Column Name	Missing values
PolicReqPerOffic	1675(84%)	PolicAveOTWorked	1675(84%)
PolicPerPop	1675(84%)	RacialMatchCommPol	1675(84%)
PctPolicWhite	1675(84%)	PctPolicBlack	1675(84%)
PctPolicHisp	1675(84%)	PctPolicAsian	1675(84%)
PctPolicMinor	1675(84%)	OfficAssgnDrugUnits	1675(84%)
NumKindsDrugsSeiz	1675(84%)	LemasSwFTFieldPerPop	1675(84%)
LemasTotReqPerPop	1675(84%)	LemasSwFTFieldOps	1675(84%)
LemasSwFTPerPop	1675(84%)	PolicCars	1675(84%)
PolicOperBudg	1675(84%)	LemasPctPolicOnPatr	1675(84%)
LemasGangUnitDeploy	1675(84%)	LemasSwornFT	1675(84%)
PolicBudgPerPop	1675(84%)	LemasTotalReq	1675(84%)
OtherPerCap	1(0.05%)		

Table 1: Total number of rows: 1994

Preprocessing

Listwise deletion:

- $=$ Method for handling missing data
- Delete columns or rows that have any missing data at all
- Very simple method to deal with missing data
- Loss of information, and thus loss in the quality of the prediction
- Good method so long as we retain sufficient power after deletion

Preprocessing

Imputation:

- $=$ Method for handling missing data
- Replace missing values with substituted data
- Ex: Median, Average,...
- Less loss of information
- May introduce bias in the correlation
- Leads to lower standard errors, which may lead to Type 1 errors

Preprocessing

Why can we use listwise deletion on the columns with 84% of missing data?

- Most of the entries are missing, thus we don't lose too much data
- We have very little data left to base our imputation on, which would make it a bad choice

Preprocessing

How do we handle the one missing entry in the OtherPerCap column?

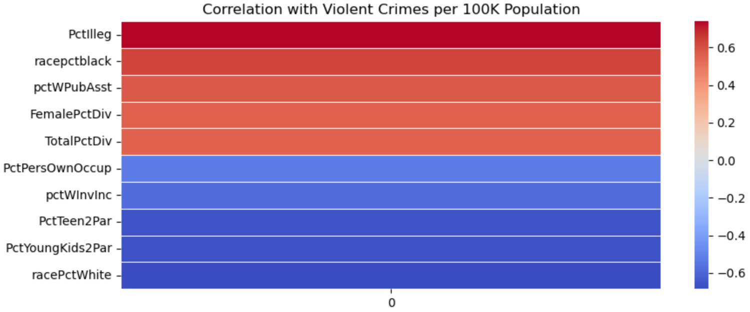
- Delete the column, but we would lose 1994 entries
- Use imputation, which should work well in this case
- Delete the row, and lose one out of 1994 rows = minimal loss of information

We deleted the row containing the missing value to keep our code as simple as we can

Correlation analysis

- Before applying a regression algorithm, it would be interesting to check which predictors are significant
- Thus we plot a graph with the correlation between the predictors and violent crime
- We exclude all predictors with a correlation that lies close to 0

Correlation analysis



Correlation analysis

INSERT CLOSER ANALYSIS OF SOME OF PREDICTORS WITH BEST CORRELATION (OR INVERSE CORRELATION)

Regression

- Given that our response variable is continuous, we have to perform regression to predict it
- Idea: Use random forest regression

Regression

What is random forest regression?

- Based on ensemble learning
  - = method where multiple ML algorithms are combined
- Utilises subsets of the data to create multiple trees (= bagging)
- The obtained results are averaged to create the final result

Regression

What are the advantages of random forest regression?

- Performs well with little to no hyperparameter tuning
- Rarely overfits
- Low sensitivity to noise
- Good at noticing general patterns in the data

Regression

What are the disadvantages of random forest regression?

- Bad at extrapolation
- Makes predictions only in the range of data contained in the training set

Regression

Why can we use random forest regression?

- Our data seems to be diverse enough to cover a realistic range of crime rates
- It seems unlikely that we might have to predict a crime rate that is much higher than in our training set
- We have quite a few predictors left, even after cleaning, thus overfitting could be an issue

Sources

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