Detecting Brick Kilns Zones Employing Child Labor Using Deep Learning and Remote Sensing

Haode, Yuqing, Qinhan, Can, Yan

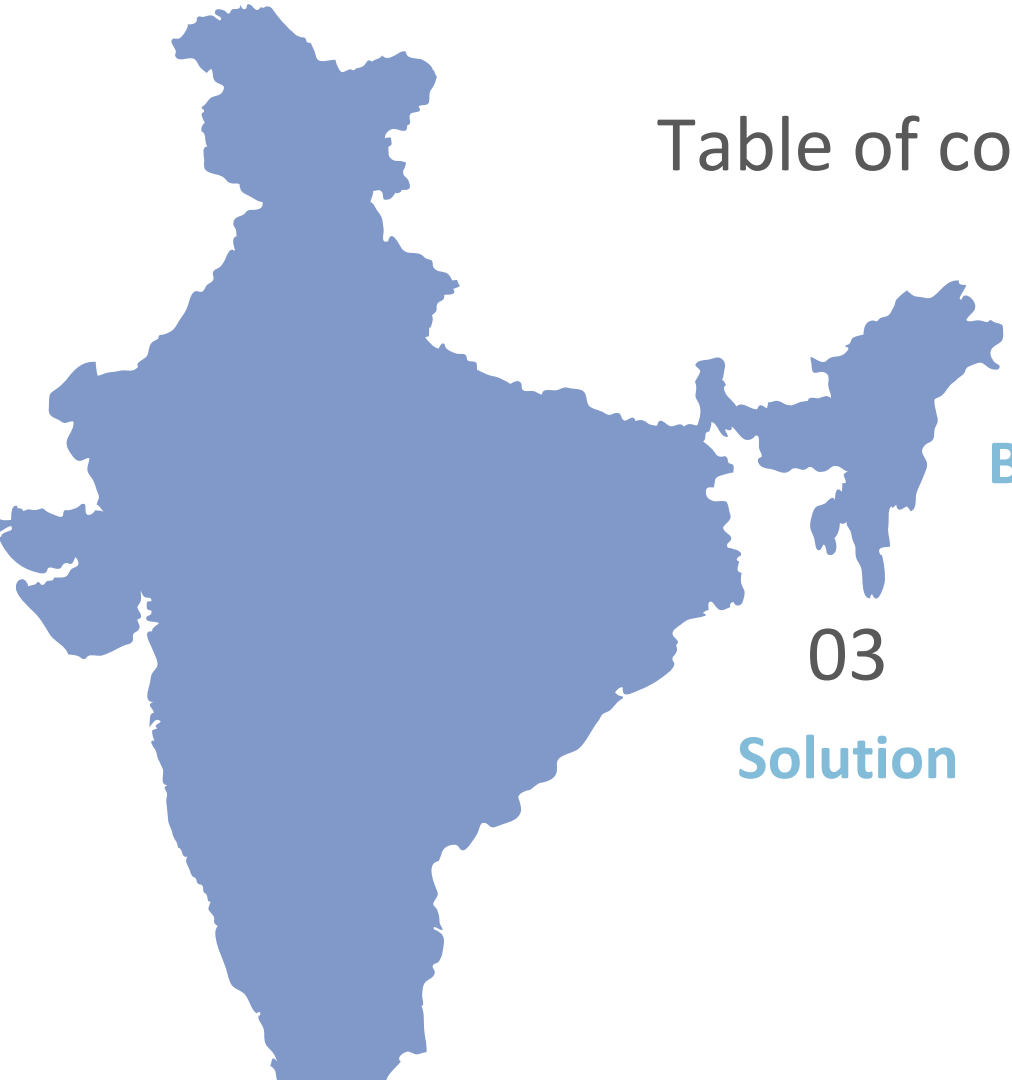


Table of contents

Background

The problem of child labor in India has always existed. Studies have found that there are a large number of child laborers in India. They are disadvantaged in family, traditional and political environments. They are forced to do dangerous work under conditions of poverty, lack of education and safe drinking water.

- 126 million children are defined as child laborers (Kumar, 2020)
- More than 70% of child laborers work in hazardous environments (e.g. brick kilns, weaving factories and dye factories) (Roy, 2019)
- About 500,000 to 600,000 children are involved in the brick kiln industry (5%) (Singh et al, 2016)

Harm of Brick Kiln Industry to Child Labor

- Physical health impact - exhausting, body pain, respiratory illness, musculoskeletal disorders, etc.
- Mental health impact - As they do not have the opportunity to participate in normal childhood activities, do not have the opportunity to attend schools, and do not receive normal health care and education (Raj et al., 2016).
- Social and cultural impact - As child labor is forced into society early, this can destroy family and social traditions, disrupt family education, lack of good social influence (Chandra et al., 2016).

Apporch

This project aims to use international positioning and satellite data to identify brick kilns, thus identifying areas where child labor and forced labor practices are likely to occur and, to some extent, eliminate this phenomenon from the global supply chain effectively.

- Using spatial data to identify brick kilns to identify areas at risk of child labor and forced labor.

- Overlaying the brick kiln location on the population kernel density map for visual analysis.

Datasets

1.Training Data:

India satellite images: download from Google images and saved them in tiff format.
Brick Kiln Location: Shapefiles with brick kilns located in India, we converted its format to XML.
https://ivt.maps.arcgis.com/home/item.html?id=67c22a5c89b946f781c519ba2399edeb

2.Labelled Data:

Shapefile of the kilns in India
https://ivt.maps.arcgis.com/home/item.html?id=67c22a5c89b946f781c519ba2399edeb858

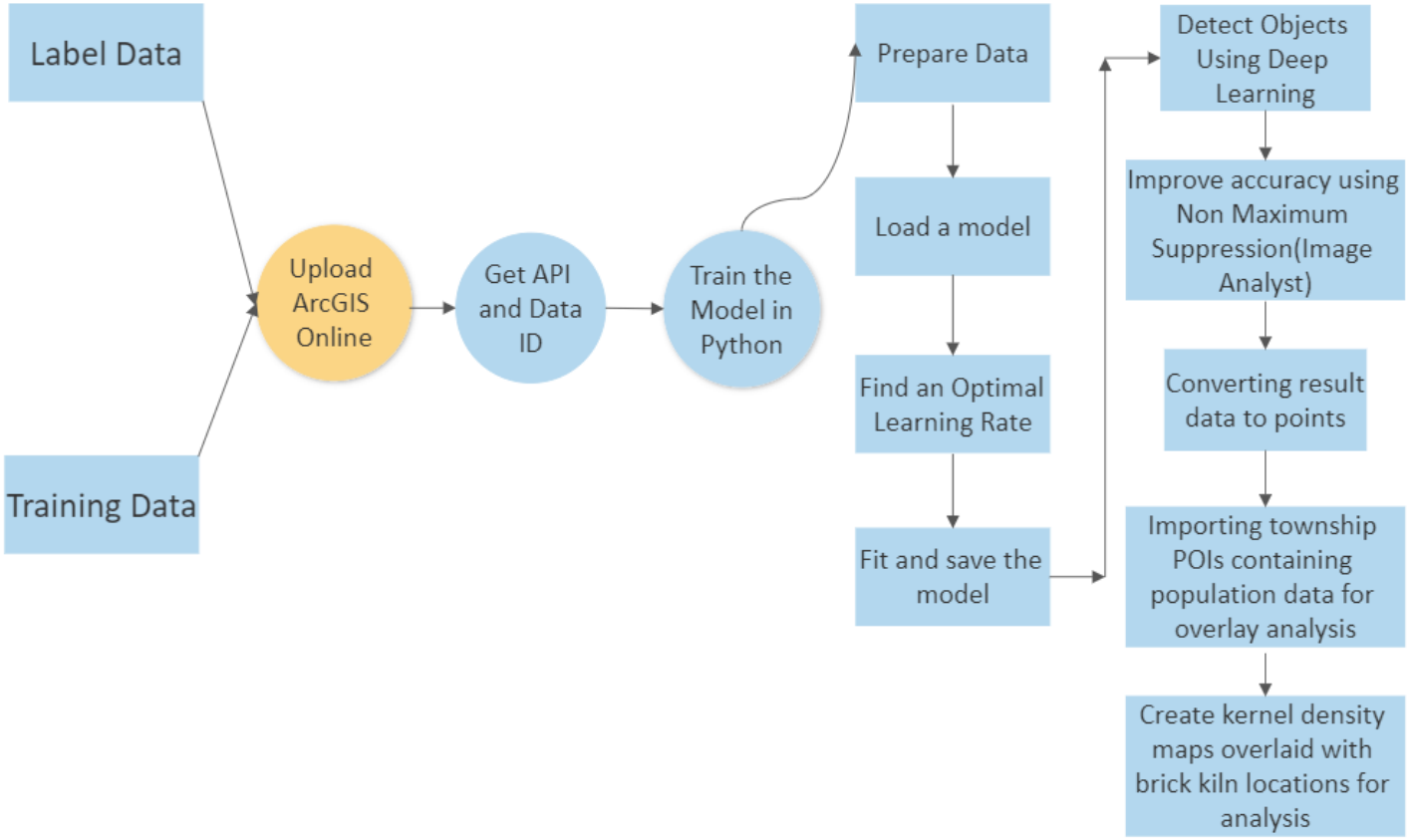
3.Test data:

India satellite images: provide by Minerva, which is the images near Jaipur of India

4.Population data:

POI Data of Test Area: Demographic information is in the property sheet of the POI
https://download.geofabrik.de/asia/india/northern-zone.html

Workflow

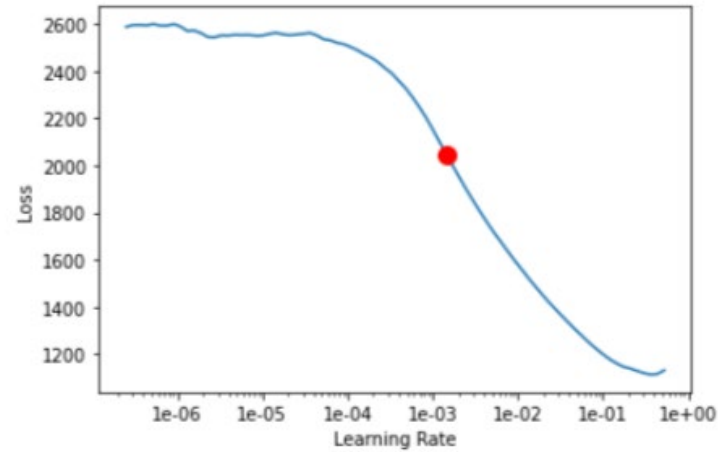

Label Data
Training Data
Upload ArcGIS Online
Get API and Data ID
Train the Model in Python
Prepare Data
Load a model
Find an Optimal Learning Rate
Fit and save the model
Detect Objects Using Deep Learning
Improve accuracy using Non Maximum Suppression(Image Analyst)
Converting result data to points
Importing township POIs containing population data for overlay analysis
Create kernel density maps overlaid with brick kiln locations for analysis

Ground Truth / Predictions

Visualize a few samples from your Training data

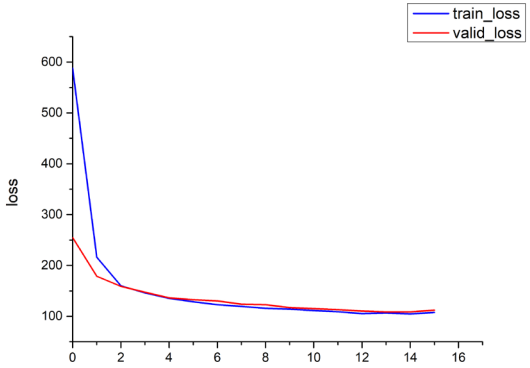
Find an Optimal Learning Rate

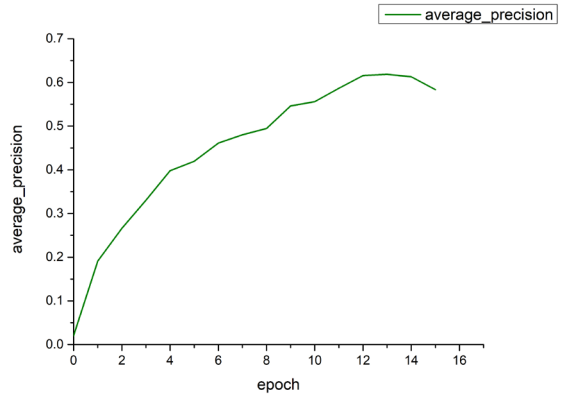
```
model.lr_find()
```

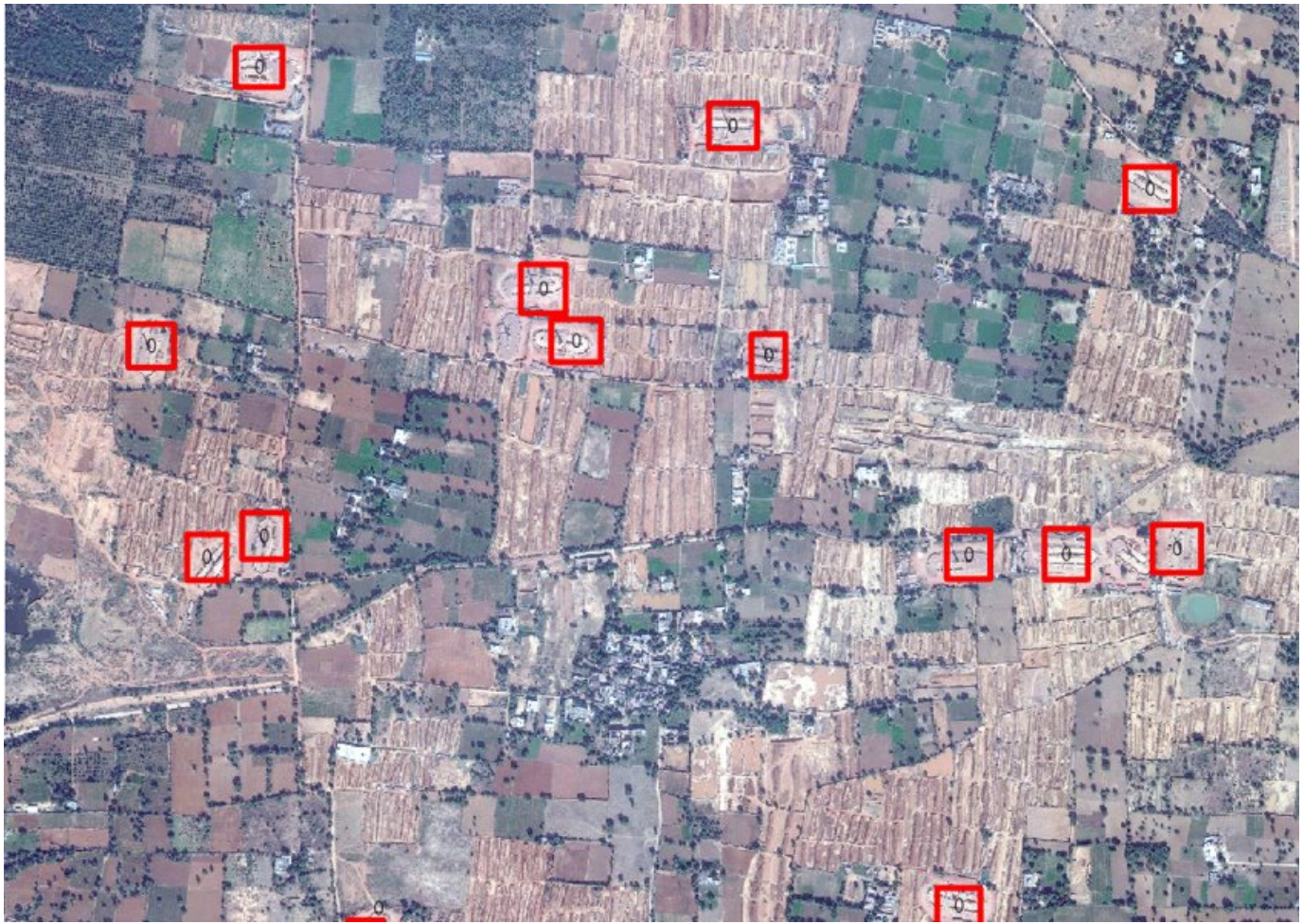



```
0.001445439770745928
```

epochs = 16
lr = 0.001
Average precison = 0.58



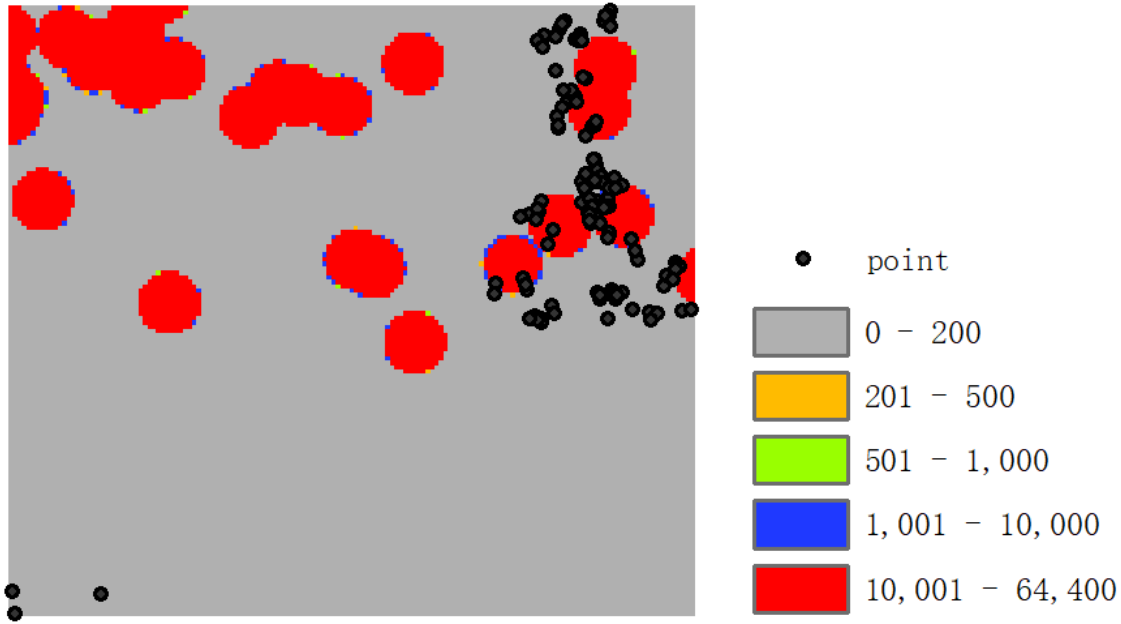




Number of brick kilns = 117

Relationship between brick kiln location and population

Brick kiln distribution and population kernel density map



Ways to improve model accuracy

1. Improving image accuracy

We selected images from Google images on the 91 Guardian platform, but due to the limitation of data volume, we only selected the data with the 15th level of accuracy (the highest level is 19).

2. Replace the training model

We only trained **SingleShotDetecter model**, ArcGIS Pro also provides training methods for other models, which we did not utilize due to time constraints.

3. Improve model accuracy with ArcGIS tool

Using Non Maximum Suppression (Image Analyst) in ArcGIS Pro.

Conclusion

Our models show that classifying brick kilns satellite images can be successfully classified using deep learning methods.

The SingleShotDetector model presented here had achieved 0.58 average accuracy over 16 iterations, and enhanced detection precision in ArcGIS Pro, effectively identifying 117 brick kilns across 488 images.

The kernel density map of the population and overlaid the brick kilns' locations to find that whether brick kilns are located in the more densely populated villages and towns or not. In India, the production of brick kilns is labour-intensive, which also justifies their location near densely populated areas.

Future Work

1. Improving the accuracy of Label data.

Improved resolution of images
More accurate label capturing
More label samples are circled for machine learning

2. Change the study area.

Other regions or countries can be selected to further study the 'Child Labour' problem

3. Linking brick kiln location data to other socio-economic data

Correlation analysis of brick kiln location with data on children's education level, household income, etc.

Reference

- Chandra, A., Budden, A., Singh, N. and Menon, P. 2016. Sexual and reproductive health and rights of children in India: A systematic review. Reproductive Health. **13**(1), pp.139
- Gupta, L. and Maurya, S. 2016. Determinants of child labour in brick kilns in India. International Journal of Applied Behavioral Economics. 5(3), pp.27-36.
- Kumar, D., Mishra, M. and Kulkarni, V. 2015. A study of health hazards of child labor in brick kilns. International Journal of Research in Engineering. Technology and Sciences. 2(1), pp.24-27
- Kumar, P. 2020. Child Labour in India: A Review. International Journal of Recent Trend in Social Sciences. 5(1), pp.1-7.
- Lee, J., Brooks, N.R., Tajwar, F., Burke, M., Ermon, S., Lobell, D.B., Biswas, D. and Luby, S.P. 2021. Scalable deep learning to identify brick kilns and aid regulatory capacity. Proceedings of the National Academy of Sciences. 118(17).
- Roy, S. 2019. Child Labour in India: An Overview. International Journal of Legal Studies and Research. 4(1), pp.1-7.

Thank you for listening!

We welcome any

suggestions and questions.