Development Pattern Analytics upon Deep Learning

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Contents

- Background
- Methodology and results
- Conclusions

Background
City Trees

Different development categories

Our tasks

A Based on built-up areas
B Finding characteristics during urbanizations
C Finding patterns, regularities, periodic over the period of time

Note: We conduct the analyses for the built-up areas within Yangtze Delta, China
Methodology and results

02 Grid based Data Model

Build-up are ≠ a city area:
- Need to map city data to built-up area
- Using improved GHSL to map data based on grid (1km x 1 km)

The GHSL method is design to combine information from population censuses with built-up and to downscale population into a grid of 1Km of resolution, according to the presence or absence of built-up in the grid cell.
03 Grid based Data Model

Data mapping examples

Shanghai

City of Bengpu, Anhui Province

02 BiLSTM Classifier

Using BiLSTM to classify the development patterns (categories) for built-up areas
Our classification model

- Input Layer
- LSTM Layer
- Dropout
- Multi-LSTM Layers
- BiLSTM Concat
- Softmax Layer
- Output Layer

+ other datasets

### Attributes used in the classifier

<table>
<thead>
<tr>
<th>Model</th>
<th>Accuracy</th>
</tr>
</thead>
<tbody>
<tr>
<td>LSTM</td>
<td>0.79310346</td>
</tr>
<tr>
<td>BiLSTM</td>
<td>0.8965517</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Attributes</th>
<th>Classification accuracy (one attribute only)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Population in the area</td>
<td>0.820689664</td>
</tr>
<tr>
<td>GDP of the area</td>
<td>0.6137930926</td>
</tr>
<tr>
<td>Financial income of the area</td>
<td>0.565517</td>
</tr>
<tr>
<td>Financial expenditure of the area</td>
<td>0.524138</td>
</tr>
<tr>
<td>Total investment in fixed assets</td>
<td>0.613793</td>
</tr>
<tr>
<td>Total retail sales</td>
<td>0.558621</td>
</tr>
<tr>
<td>Import/export</td>
<td>0.448276</td>
</tr>
<tr>
<td>Industrial output</td>
<td>0.641379</td>
</tr>
<tr>
<td>Passenger traffic</td>
<td>0.77931</td>
</tr>
<tr>
<td>Freight volume</td>
<td>0.57931</td>
</tr>
<tr>
<td>Total consumption expenditure</td>
<td>0.613793</td>
</tr>
<tr>
<td>Number of employed people</td>
<td>0.572414</td>
</tr>
<tr>
<td>Total household disposable income</td>
<td>0.57931</td>
</tr>
</tbody>
</table>
Clustering built-up areas upon their development patterns over the time, the best number of clusters is 5:

- Explosive growth
- Rapid growth
- Moderate growth
- Slow growth

Growth rates changing (in clusters) over the time.
Different development categories

Number of development categories in different years
Conclusions

The result of clustering using multi-dimensional time series is coincident with city trees and their categories.

The population growth trend is consistent with the development trend of an area.

BiLSTM is able to capture multi-dimensional time series as whole and their trends.

The result of clustering using multi-dimensional time series is coincident with city trees and their categories.
Thank You