Zoom and Boom: How Satellites Expose Urban Expansion Secrets

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The models discussed herein are not currently in use by J.P. Morgan (08/16/2023).
01 PROJECT GOAL
02 THE DATASET
03 ANALYTICAL METHODS
04 RESULTS AND BUSINESS IMPACT
05 FUTURE APPLICABILITY
01 PROJECT GOAL
Over 4700 Chase branches, optimizing network key for profitability
PROJECT RELEVANCE

Where would you place a new retail branch?
PROJECT RELEVANCE

Where would you place a new retail branch?
PROJECT GOAL

Predict future urbanization rate in any given area

Satellite Images

Dynamic World Segmentation (red = built)
02 THE DATASET
Google's 10m-resolution land cover segmentation, from 2016 to present, with daily images and nine labels.
Create a fishnet over the desired area. Extract in batches called regions. We extract one image per batch (region) per year.
QUANTIFY URBANIZATION

Percentage urbanization as average number of red pixels for each fishnet tile. Map shows percentage urbanization in different regions.

urb = 0.72
03 ANALYTICAL METHODS
Spatial component:
Macro-trends, urbanization in different regions is correlated
Temporal component:
Different regions follow specific urbanization patterns
Capture spatio-temporal relationships using previous frames (**past satellite images**) to predict future ones (**next year urbanization**)
MODELING PIPELINE

Complex sequence of classification and regression tasks to improve upon baselines
RESULTS AND IMPACT
Adding new feature(s) that improve **downstream models**

<table>
<thead>
<tr>
<th>Feature</th>
<th>Urbanization prediction</th>
<th>Feature</th>
</tr>
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<tbody>
<tr>
<td>Region</td>
<td></td>
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<td>Region</td>
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Scalable and reusable **codebase**
**EVALUATION METRICS**

Our approach (ConvLSTM) outperforms baselines on principal metric (MAE)

<table>
<thead>
<tr>
<th></th>
<th>MAE</th>
<th>RMSE</th>
<th>$R^2$</th>
</tr>
</thead>
<tbody>
<tr>
<td>Historical Average</td>
<td>0.024</td>
<td>0.047</td>
<td>0.973</td>
</tr>
<tr>
<td>XGBoost</td>
<td>0.010</td>
<td>0.022</td>
<td>0.992</td>
</tr>
<tr>
<td>ConvLSTM</td>
<td><strong>0.009</strong></td>
<td>0.026</td>
<td>0.981</td>
</tr>
</tbody>
</table>

Ensemble learner for further improvement
05 FUTURE APPLICABILITY
THEORETICAL USE CASES IN FINANCIAL SERVICES

Same methodological framework applicable to a variety of other projects

Real Estate Investment
Collateral Risk Assessment
Natural Disasters Evaluation
THANK YOU
Convolutional LSTM

Convolutional Long-Short Term Memory Neural Network. Convolutions enable to learn spatial features, LSTMs to capture temporal relationships.

Source: Learning Multiscale Temporal-Spatial-Spectral Features via a Multipath Convolutional LSTM Neural Network for Change Detection With Hyperspectral Images
Night Time Light

Additional data source that captures vertical urbanization
Data Preprocessing

Clouds cause missing pixels, data imputation to restore correct image
Clean and organized code, adherence to **best practices**, ensuring reusability and knowledge transfer.