Understanding Deforestation of Amazon using CNN-RNN

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Motivation: why deforestation matters

Losing 48 football fields every minute!

Other severe effect:
1. Limit product harvest from forest;
2. Plant and animal species go extinct.
3. The natural water cycle gets altered.

Identify reason: Natural causes, Human behavior.
Problem Statement

Input:
Satellites Image of Amazon Basin (3 meter pixels)

Output:
Multiple labels for single input image (17 unique labels)
Data Set


Training Labels:

Figure 1: #of Labels  
Figure 2: Co-occurrence Matrix
Related Work

Other dataset:
MODIS: 250m
OLI: 30m

Contributions: Pretrained ReNet[1]

ResNet architecture:
• Stack residual blocks
• Every residual block has two 3*3 conv layers.
• No fully connect layer at the end
• Only FC 1000 to output classes

Multilabel ResNet

- Replace FC1000 with FC17
- Loss Function

\[ L(s, y) = -\frac{1}{N} \sum_{i=1}^{N} [y_i \log\left(\frac{e^{s_i}}{1 + e^{s_i}}\right) + (1 - y_i) \log\left(\frac{1}{1 + e^{s_i}}\right)] \]

- Set threshold for each label when predicting

\[ S(s_i) = \frac{1}{1 + e^{-s_i}} \]
Contribution: CNN-RNN Model

RNN: Process Sequence

Replace

Single FC: V

\[ y_0 \]
\[ y_1 \]

\[ W_v \]
\[ W_h \]

\[ RNN \]
\[ FF \]
Contribution: CNN-RNN Model

Ground truth label: $L = \{\text{primary, clear, agriculture}\}$

Training
- Compute $y_t$
  $$y_t = W \cdot \text{ReLU}(W_{vt} \cdot V + W_{ht} \cdot h)$$
- Normalize $y_t$
  $$y_t = \frac{e^{y_{ti}}}{\sum_{k=1}^{18} e^{y_{tk}}}$$
- Calculate cross-entropy with $L_t$
  $$\text{Loss} = -(L_t \cdot \log y_t + (1 - L_t) \cdot \log(1 - y_t))$$
Validation

• Evaluation Metric: F2 score

\[ F_2 = (1 + \beta^2) \frac{pr}{\beta^2 p + r} \]

• Results

<table>
<thead>
<tr>
<th>Model</th>
<th>Test F2</th>
</tr>
</thead>
<tbody>
<tr>
<td>ResNet-50(no pre-trained)</td>
<td>0.87934</td>
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<tr>
<td>ResNet-50</td>
<td>0.92215</td>
</tr>
<tr>
<td>ResNet-152</td>
<td>0.92687</td>
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<tr>
<td>RNN</td>
<td>-</td>
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<tr>
<td>Ensemble</td>
<td>-</td>
</tr>
<tr>
<td>Kaggle Leader</td>
<td>0.93334</td>
</tr>
</tbody>
</table>
Conclusion

• Proposed two ways to understand causes of deforestation:

1. Pre-train CNN: ResNet
2. CNN+RNN
Thank you!
References

[2] Planet: Understanding the Amazon from Space.
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