Using GANs To Augment Data For Cloud Image Segmentation Task

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Introduction

- Determining cloud coverage and distribution helps in analysis and forecasting of key weather related parameters like solar irradiance, rainfall and humidity
- WSIs provide cloud images with high temporal and spatial resolution than satellites at low cost
- Supervised methods superior than unsupervised methods for cloud image segmentation
- But, supervised methods need vast amount of labelled data for training
- GANs proven useful for data augmentation
- Must generate ground-truth maps along with raw sky/cloud images to make them useful in this case
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Dataset and Pre-processing

- SWINSEG\(^1\) dataset contains 115 images with \(500 \times 500\) pixel resolution
- All images are accompanied with ground truth binary maps
- Contain night-time cloud/sky images only
- Extracted \(R - B\) channel only to diminish the blur between cloud edges and night sky\(^2\)
- To train image segmentation model, data splitting was done as follows:
  - Training Set: 69 Images (60%)
  - Validation Set: 18 Images (15.65%)
  - Test Set: 28 Images (24.35%)

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Process Pipeline

- **Original Dataset**
  - Generate Sky/Cloud Image using GAN
  - Estimate Segmentation Map using Unsupervised Clustering

- **Augmented Dataset**
  - Train supervised image segmentation model (PLS Regression Model)

- **Validation Loss (VL1)**
  - VL1 ≥ VL2 ?
  - Yes: Select the augmented image/segmentation map pair
  - No: Discard the augmented image/segmentation map pair

- **Validation Loss (VL2)**
  - Train supervised image segmentation model (PLS Regression Model)

**Methodology**
### Results

<table>
<thead>
<tr>
<th>Cases</th>
<th>$R^2$ (Training)</th>
<th>$R^2$ (Test)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Without Augmentation</td>
<td>0.568</td>
<td>0.372</td>
</tr>
<tr>
<td>After Augmentation</td>
<td>0.539</td>
<td>0.377</td>
</tr>
</tbody>
</table>

Coefficient of determination ($R^2$) as calculated when the PLS model was trained without augmenting the training set and after augmenting the training set.
Augmenting images using GANs helps in reducing the problem of overfitting.

PLS, being a relatively simple segmentation model, can be trained quickly and hence can be used to discard poorly generated image-segmentation map pairs.

Augmentation by basic image transformation techniques can still be applied to GAN augmented images.

In future, we would like to:
- use the augmentation method to improve the accuracy of state-of-the-art cloud/sky image segmentation models.
- modify the GAN architecture such that they may generate the corresponding segmentation maps too.
Conclusion & Future Work

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Thank you for your attention!