**Introduction**

- Recently, new and deep learning sizeable datasets with Remote Sensing Multi Spectral Imagery have come forward.
- Earth is not covered equally by semantically meaningful classes, leading to severe class imbalances in Land Cover Datasets and poor recognition results.
- We improve the performance on these minority classes with up to 20% without strong effects on majority classes.
- Utilizing the CLC Classes as Attributes improves accuracies on new parent classes[3]

**Highly Imbalanced Data**

- BigEarthNet[1] dataset with nearly 600,000 multi-class multi-label multispectral images
- Sentinel-2 satellite imagery matched with CORINE Land Cover (CLC) inventory
- 12 spectral channels including RGB and IR
- 120 x 120 px with 10 [m²] to 60 [m²] Res.
- 43 Classes with sample counts between 60 in minority and 40,000 in majority classes

**Minority Class Agnostic Sampling**

- Minority class marginal probability based data
- **Random Oversampling process (MROS) produces sample weights**
  \[ \text{M}(B, W_{\text{sampled}}) = \left( \frac{B}{y_1 \ldots y_M} \right)_{x} \]
  \[ \text{Sampling Process of one epoch} \]
- **Dynamic Class Weight (DCW) adjustment in loss during training with BCE.**
  \[ L_{\text{BCE}}(\epsilon) = \frac{1}{C} \sum_{c=1}^{C} w_c (y_c \log (\hat{y}_c) + (1 - y_c) \log (1 - \hat{y}_c)) \]

**Minority Agnostic Metric**

- Inverse proportional weighting of classes in averaging metrics: **minor weight**
  \[ F_{\text{Inverse}} = \sum_{c=1}^{C} \frac{1}{F_{\text{c}} + \mu_{\text{c}}} \]

**Experiments**

- **Densnet121[19] backbone**
- **Upsampling of all spectral channels**
- **Different ablations:** CW, MROS + DCW, PT (Pretraining on ImageNet)
  - Two different data splits [%] with training/test/validation mean Class Probabilities [µC%]
    - 1. New Split 70/20/10 [%] with 70.1/19.9/10.0 [µC%]
    - 2. BigEarthNet Split[1] 52/24/24 [%] with 61.3/20.7/17.9 [µC%]

**Comparison to SoA**

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<tr>
<th>Method</th>
<th>MROS + DCW</th>
<th>MROS + DCW + PT</th>
<th>Data</th>
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<tr>
<td>BigEarthNet</td>
<td>52.6</td>
<td>80.8</td>
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**Conclusion**

- Our method pushed the detection of semantically very meaningful minority classes in multi-label remote sensing imagery
- MROS and DCW increase the performance of minority classes by up to 20% with only minimal changes to the majority classes
- Pre-Training on ImageNet is especially beneficial for minority classes.
- Better analysis of model performances on highly imbalanced multi-label data through minority agnostic metric
- Attribute based class encoding produces superior classification performances for a reduced set of parent classes and is identified as a promising research direction

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**Selected References**


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