Wheat crop identification using Kernel Based Possibilistic c-Means Classifiers

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Introduction

- Accurate specific crop maps are relevant to yield estimation as well as crop cycle study.
- Mapping specific crop using single date imagery is a challenge.
- Occurrence of mixed pixels, leads to over estimation or underestimation of the target class.
- Soft classification has significant advantages over hard classification.
Classification techniques

- Used PCM classifier with kernels.

- PCM is less effective to separate identical classes.
Objectives

- To evaluate number of temporal images sufficient for early and late wheat crop identification.
- To obtain best-suited kernel integrated with PCM and IPCM classifier.
- Comparison of classified results obtained by KPCM and KIPCM classifier.
The study area under this research is East side of Haridwar, Uttarakhand, India.
Field Photographs

- Late Wheat Crop
- Fallow Land
- Dense Forest
- Water Body
- Forest
- Riverine sand
- Early Wheat crop
- NH 74
Data used

Formosat-2 temporal data
Spatial resolution - 8m

Landsat-8 (OLI) temporal data
Spatial resolution - 30m

Datasets | Number of dates combined | Reference code of date combination
--- | --- | ---
Dataset A | 4 date combination | F1-F2-F3-L1
Dataset B | 5 date combination | F1-F2-F3-L1-L2
Dataset C | 6 date combination | F1-F2-F3-L1-L2-F4
Methodology

Pre-Processing

Formosat-2 Temporal Data  Landsat-8 OLI Temporal Data

Geometric Correction

Atmospheric Correction

Reference Data

Creation of Training Data

Creation of Testing Data

Dataset A  Dataset B  Dataset C

Creation of temporal NDVI datasets of Formosat-2 and Landsat-8

Soft Classification using Kernel based PCM and Improved PCM Classifier

Evaluation for optimized weighted constant, best temporal date combination and best-suited kernel

1. Local kernels
   i. Gaussian
   ii. Radial basis kernel
   iii. KMOD kernel
   iv. Inverse multiquadratic
2. Global kernels
   i. Linear kernel
   ii. Polynomial kernel
   iii. Sigmoid kernel
3. Spectral angle kernel
4. Hyper tangent kernel
KPCM Classified Outputs

- Weighted constant and difference between membership value at early and late wheat test sites ($\Delta \mu$) for early and late wheat crop classes
Weighted component and difference between membership value at early and late wheat test sites ($\Delta\mu$) for early and late wheat crop classes.
Entropy: an indirect absolute classification accuracy indicator has been used. Ranges from 0 (low uncertainty) to 1 (high uncertainty)
KMOD KPCM and KIPCM

KPCM classifier (entropy: 0.0225) (a)  
Class1: Early wheat crop (Six date; optimized m= 2.3); (b) Class2: Late wheat crop (Five date; optimized m= 2.3)

KIPCM classifier (entropy: 0.00846) (a) Class1: Early wheat crop class, (b) Class2: Late wheat crop class
Polynomial KPCM and Linear KIPCM

Polynomial KPCM classifier (entropy= 0.0205) (a) Class1: Early wheat crop (Six date; optimized m= 2.3); (b) Class2: Late wheat crop (Six date; optimized m= 2.3)

Linear KIPCM classifier (entropy= 0.00965) (a) Class1: Early wheat crop class, (b) Class2: Late wheat crop class
### Temporal datasets results

#### KMOD kernel PCM results

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<th>Entropy</th>
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[Images of maps showing early and late wheat fields with different date combinations]
### Temporal datasets results

#### KMOD kernel IPCM results

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<tr>
<td>6 date combination</td>
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</tr>
</tbody>
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Early wheat

Late wheat

![Image of wheat fields with color scale](image-url)
Conclusion

- More homogeneity within wheat class was observed in KIPCM results.

- Wheat pixels from background pixels were well separated in case of kernels KIPCM as compared to KPCM results.

- The best results for wheat identification, were found to be with KMOD kernel, with 6 temporal dates combination and the corresponding entropy value was 0.00846.
Thank You