- Introduction & data description

- Applied Methodology

- Achieved Results

- Discussion

- Conclusion & future work

- Beijing, China
- Rapid growth
- Difficult to obtain good optical images due to smog and clouds
- Classification of Urban environment (synergy of SAR and optical data)
- Applies object based approach

- ENVISAT ASAR Polarized images HH/VV 32 bit
  - July 15 & 31 2008
  - September 1 & 23 2008
  - October 9 2008
- HJ1B – CCD2 Multispectral R/G/B/NIR 8 bit
  - April 26 2009

# Data preparation

Preprocessing SAR
(NEST)

Preprocessing Optical

Radiometric correction

Co-registration (NEST stacking)

Multi-temporal speckle filter

Co-registration to SAR stack (PCI)

# Segmentation (general)

- Analysis based on a group of pixels
- Representing similar objects or areas
- More than just spectral information
- Beneficial for classification

| | | | | |
|---|---|---|---|---|
| 89 | 91 | 93 | 85 | 17 |
| 91 | 87 | 85 | 14 | 15 |
| 92 | 90 | 87 | 17 | 16 |
| 47 | 14 | 17 | 45 | 20 |
| 52 | 15 | 15 | 54 | 50 |

# Segmentation

| Segmentation |
|:---:|

| Region growing (Mutual best neighbors) |
|:---:|

| Region merging (Thresh holding) |
|:---:|

| Assignment of isolated pixels |
|:---:|

Currently the average change of mean in every band in percent is used.

$$merge-indicator = \frac{\sum_n \frac{\mu_b - \mu_a}{\mu_b}}{n}$$

# Classification

Classification SVM
9 classes:
Low density built-up, High density built-up, Roads, Park, Water, Golf course, Forest, Agricultural crop, Airport

Selection of Training Segments (10 – 20 per class)
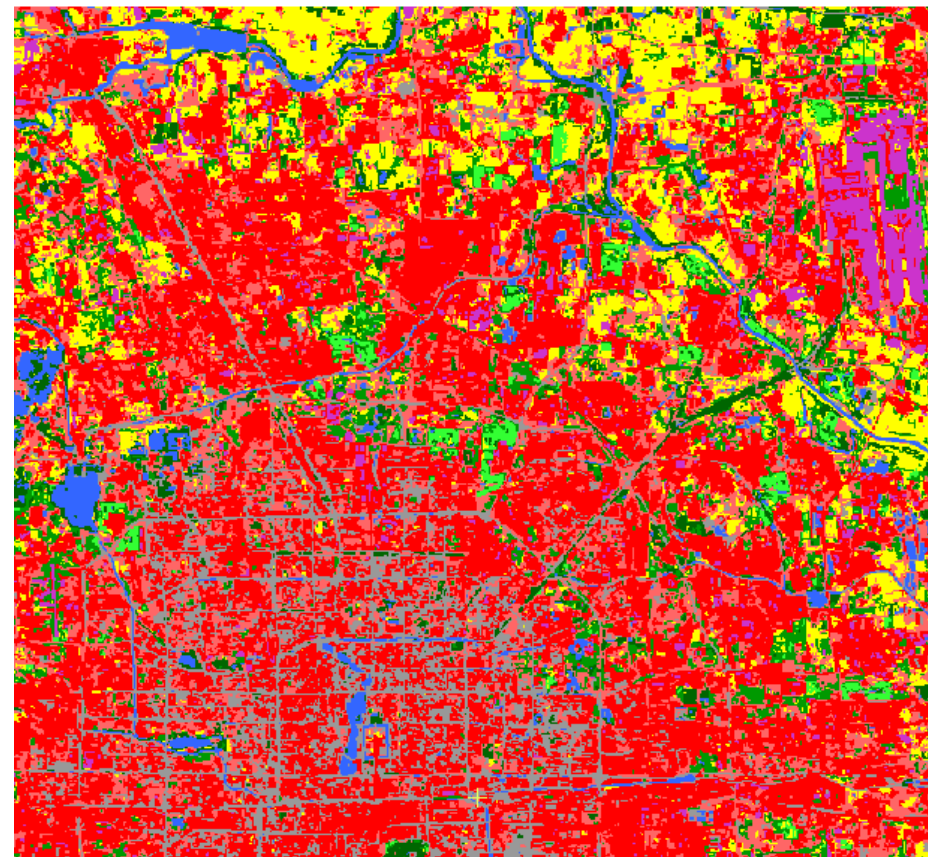
Grid Search($C, \gamma$) by Cross Validation
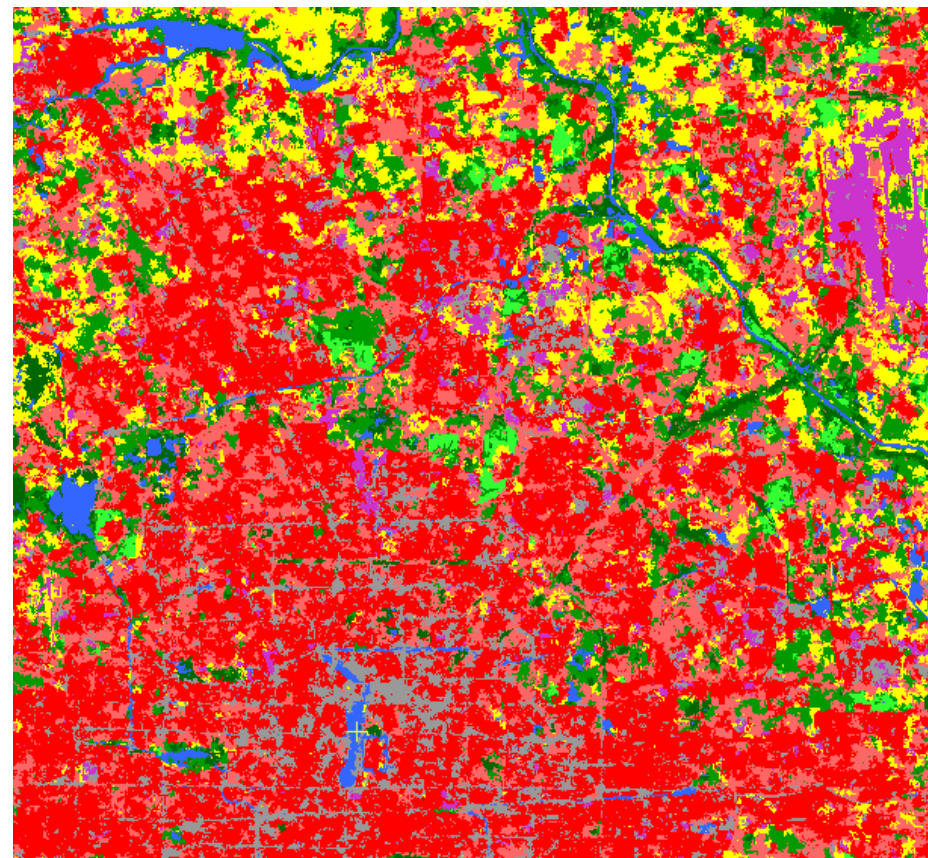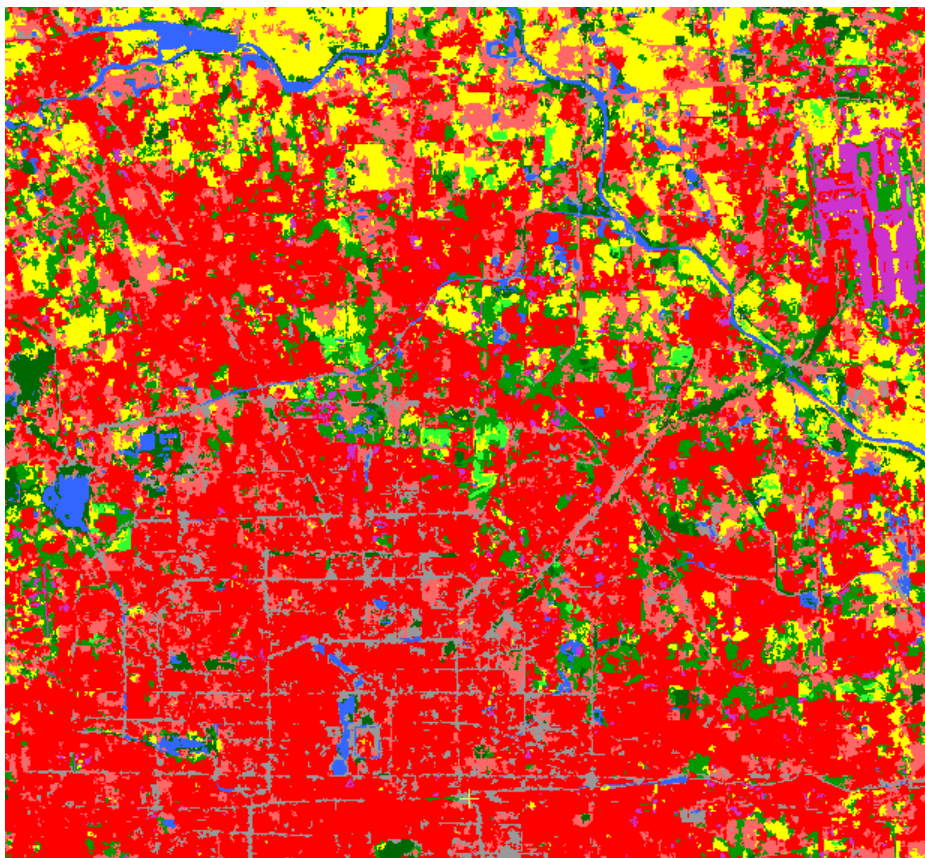
Prediction of whole dataset

Visualization (PCI)

- Low Density
- High Density
- Road
- Park
- Water
- Golf course
- Forest
- Agricultural Crop
- Airport

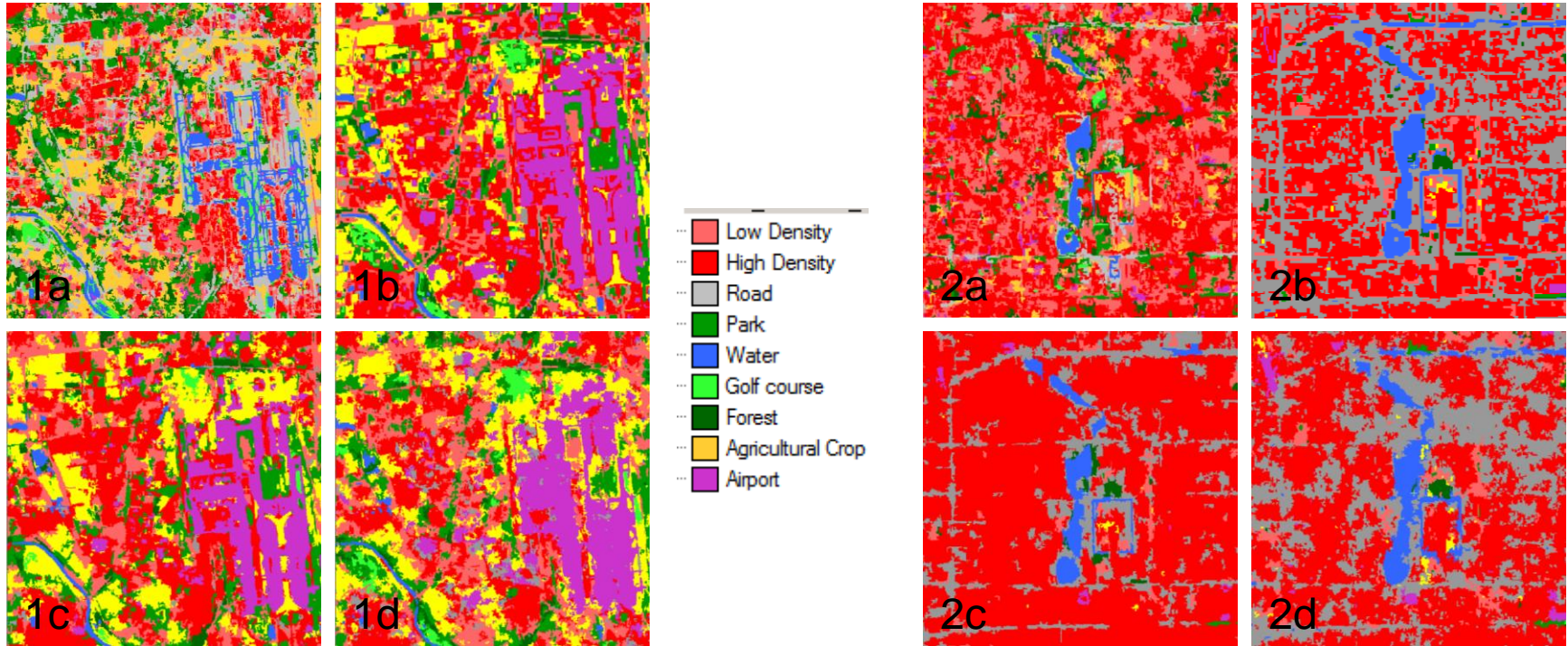The SVM is based on the java implementation of LibSVM

**Confusion Matrix with Producer's and User's Accuracy in % Fused filtered SAR**

|  | High dens | Low dens | Road | Park | Water | Golf | Forest | Agri. Crop | Airport | User's |
|---|---|---|---|---|---|---|---|---|---|---|
| High dens | **1255** | 28 | 0 | 158 | 0 | 0 | 28 | 265 | 0 | **72.38** |
| Low dens | 0 | **1360** | 155 | 0 | 0 | 0 | 0 | 0 | 0 | **89.77** |
| Road | 40 | 328 | **933** | 0 | 0 | 0 | 0 | 0 | 0 | **71.71** |
| Park | 271 | 3 | 0 | **1041** | 0 | 0 | 0 | 245 | 0 | **66.73** |
| Water | 0 | 0 | 0 | 0 | **1824** | 0 | 0 | 0 | 0 | **100.00** |
| Golfcour | 0 | 0 | 0 | 19 | 0 | **953** | 36 | 537 | 0 | **61.68** |
| Forest | 41 | 0 | 5 | 27 | 6 | 0 | **1313** | 118 | 0 | **86.95** |
| Agri. Crop | 67 | 0 | 0 | 12 | 0 | 162 | 86 | **1360** | 0 | **80.62** |
| Airport | 0 | 671 | 0 | 11 | 0 | 0 | 0 | 13 | **897** | **56.34** |
| Producer's | **74.97** | **56.90** | **85.36** | **82.10** | **99.67** | **85.47** | **89.75** | **53.59** | **100.00** | |

|  |  | ENVISAT ASAR | HJ-1A CCD2 | Fusion Filtered | Fusion Unfiltered |
|---|---|---|---|---|---|
| Validation areas | **Overall accuracy** | 40.38% | 77.83% | 76.68% | 68.75% |
|  | **Kappa Coefficient** | 0.32818 | 0.75067 | 0.73729 | 0.64847 |

1500 – 1800 pix per class for testing

**Legend:**
- Low Density
- High Density
- Road
- Park
- Water
- Golf course
- Forest
- Agricultural Crop
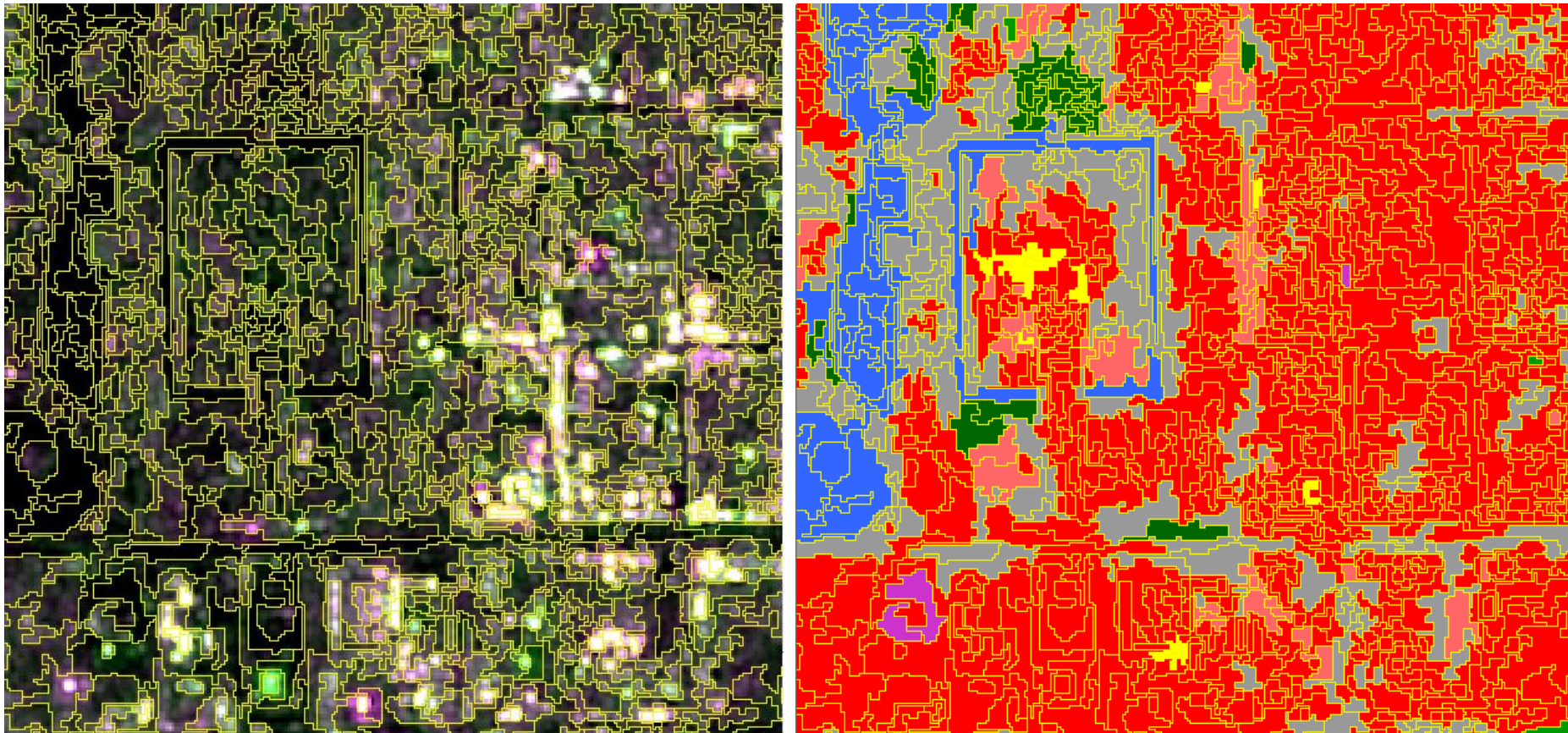- Airport

Beijing Airport

Beijing Center

A: ASAR only, B: HJ1B only, C: Fusion filtered, D: Fusion unfiltered

Segments around forbidden city

- SAR and optical observation dates not optimal

- Over segmentation

- Classes not necessarily spectrally unique

# Conclusion

- A useful framework for further research has been developed (JAVA)

- Fusion promising for urban classification tasks

- SVM can create reasonable results with little effort (supervised training)

- Improved Segmentation
  - utilizing more features (texture, shape)
  - assistance through edge detection

- Rule based classification schemes
  - Topology
  - Geometry
  - Spectrum

- Testing with other data sets and study areas

# Thank you for your attention!
# Questions?