# Determination of Relevant Hyperspectral Bands using a Spectrally Constrained CNN

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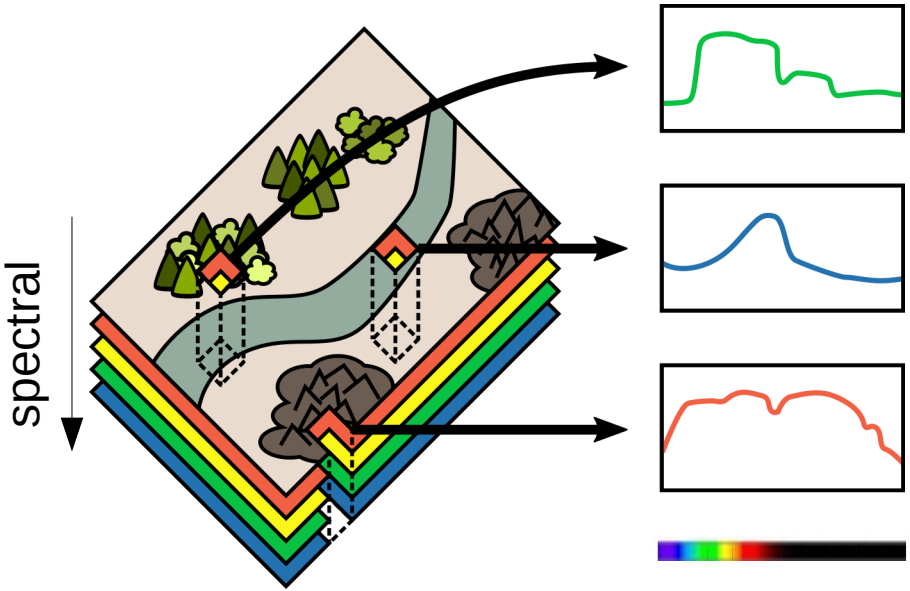
# Hyperspectral Imagery




- 3D data cube
- Wavelength range
  400 to 1000 nm
- 186 spectral bands
- Spectral signature allows identification of materials
- Applied for classification and detection

# Classification of Natural and Man-Made Fruits

RGB data

Which fruit is natural, which is man-made?

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**Goal**

- Classification of natural and man-made fruits

**Advantage of hyperspectral imagery**

- Exploitation of spectral information

**Challenge**

- High spectral dimensionality
- Computationally expensive
- Consumer friendly

## Approach

Band reduction method using CNN

- obtaining information about relevant wavelengths resp. bands → selecting relevant bands possible

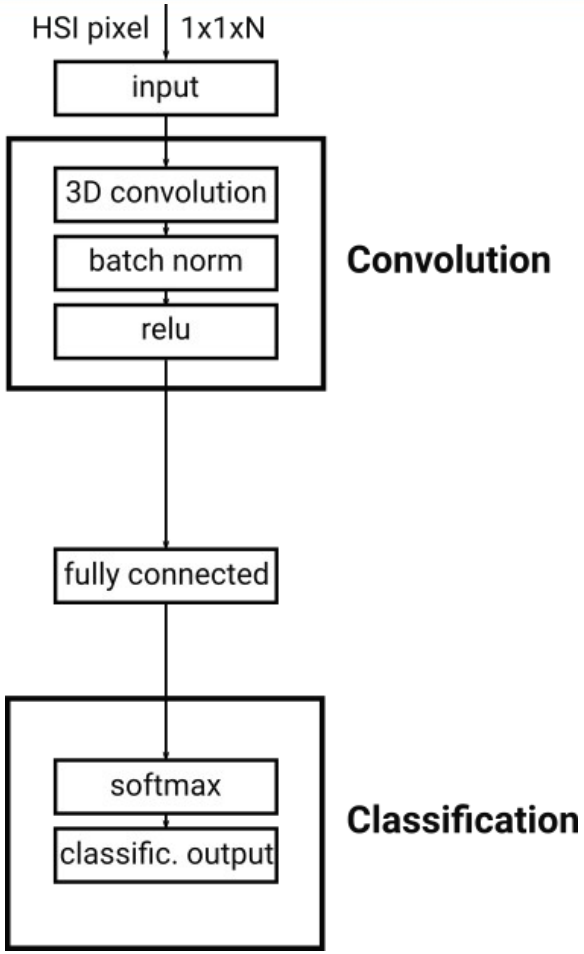
## Aim

- Few spectrometers necessary → Low cost application for customer
- No overfitting from sparse data

## Idea

- Spectrally constrained CNN
- CNN shows contribution of each spectral band to class decision.

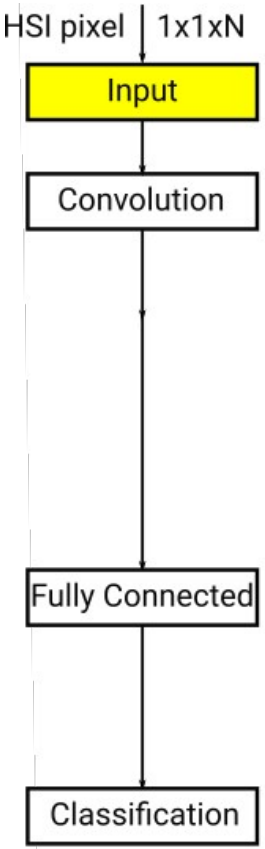
# Band Reduction Method using CNN

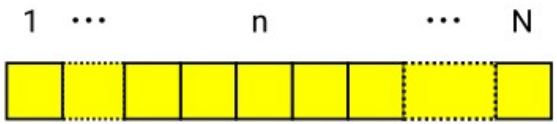



How can the spectral location of one band be maintained?

- Relationship between spectral information of input and class decision
- Layers with functions operating across the spectral bands are interesting
- Layers with pixelwise nonlinear functions not considered

# Band Reduction Method



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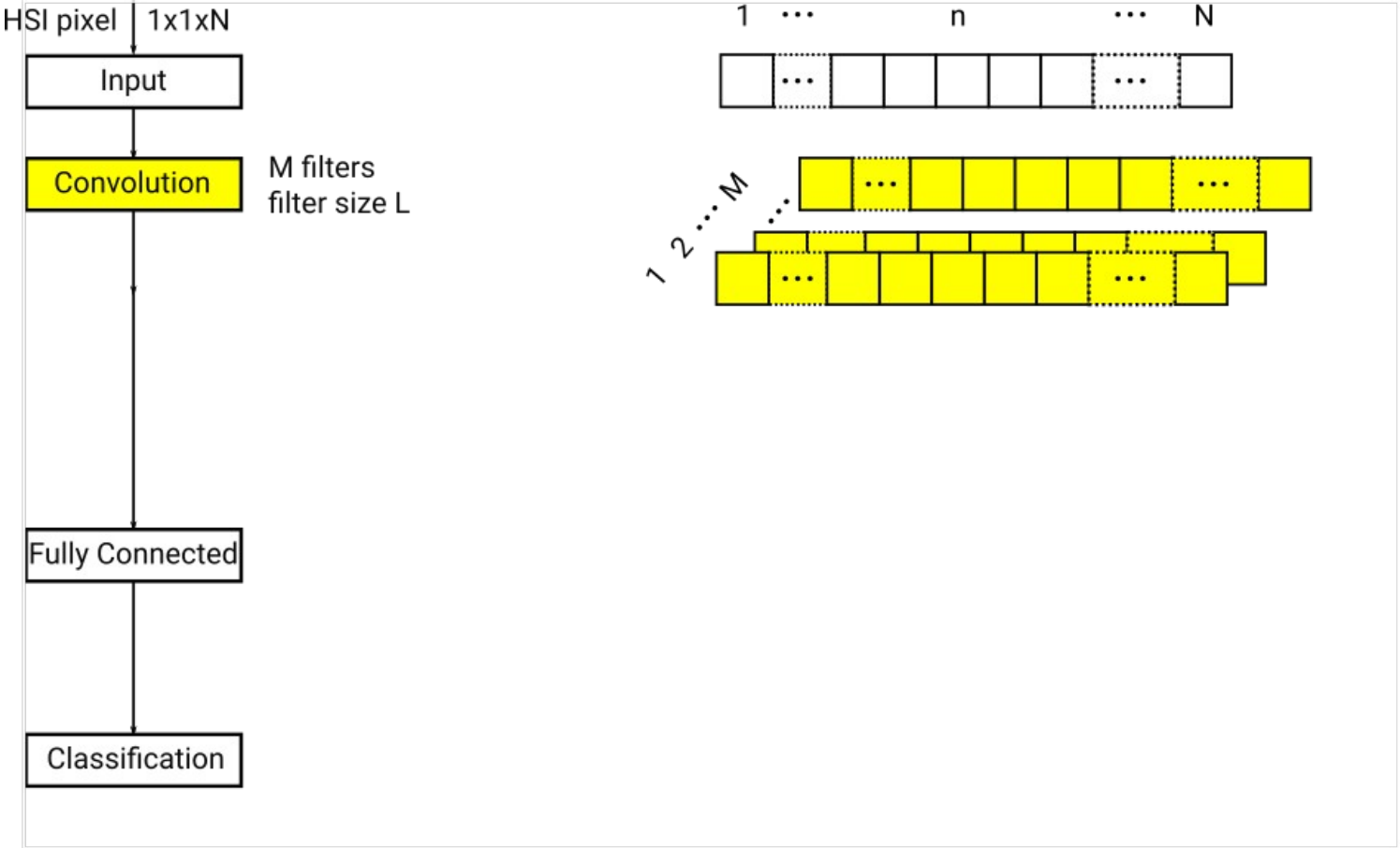

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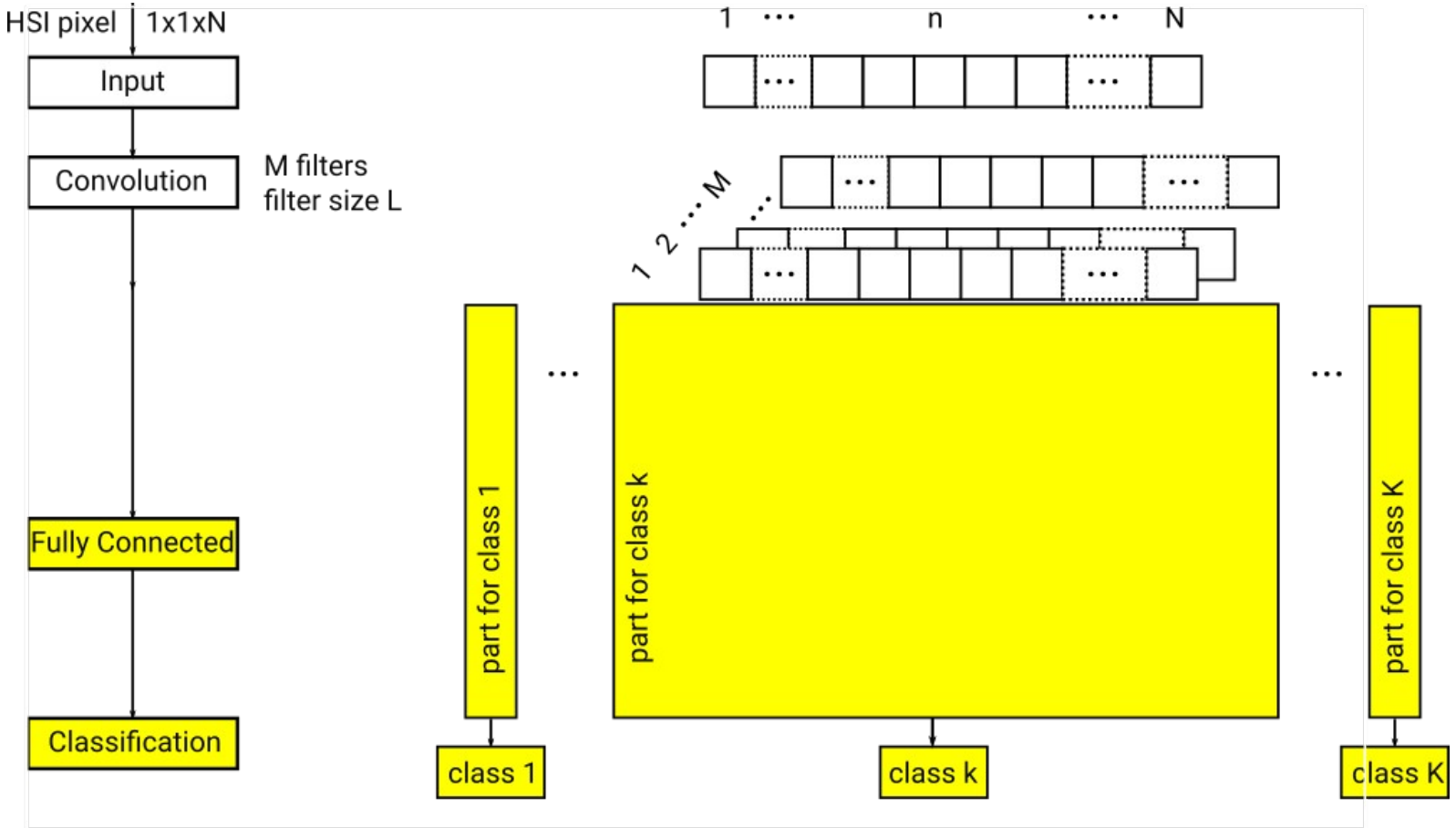

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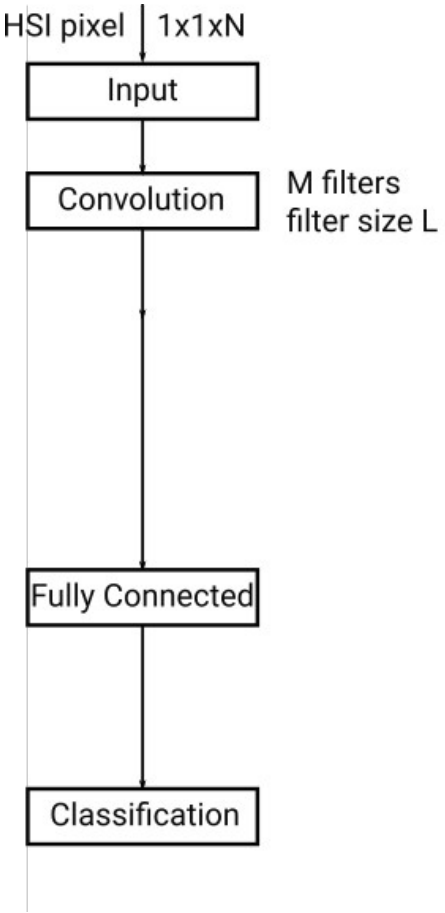
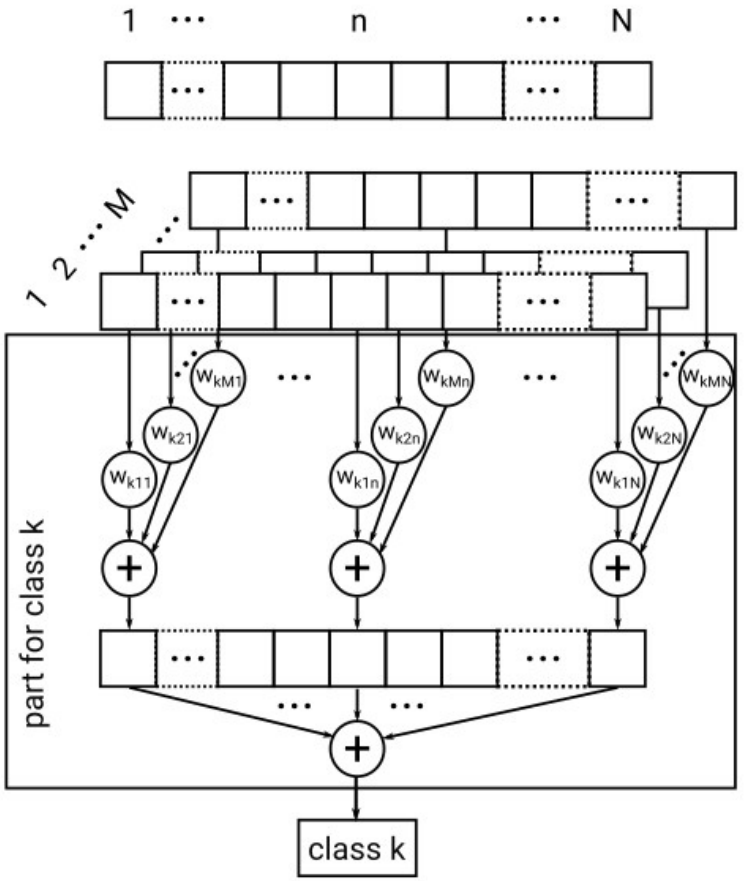
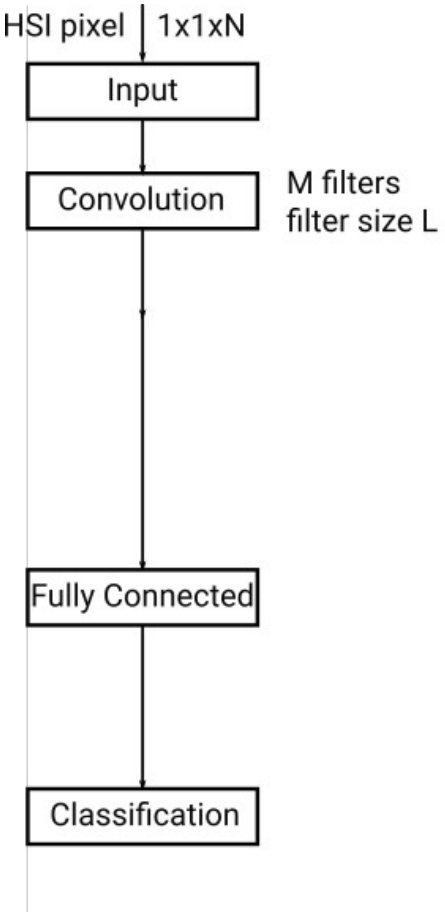
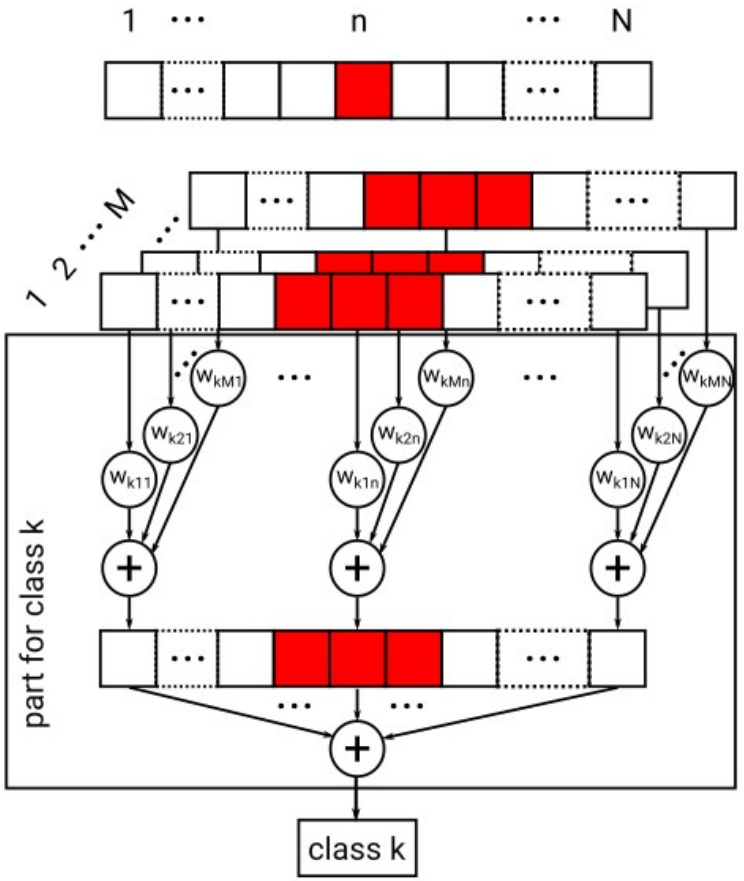



Spectral band contribution to class decision

# Band Reduction Method

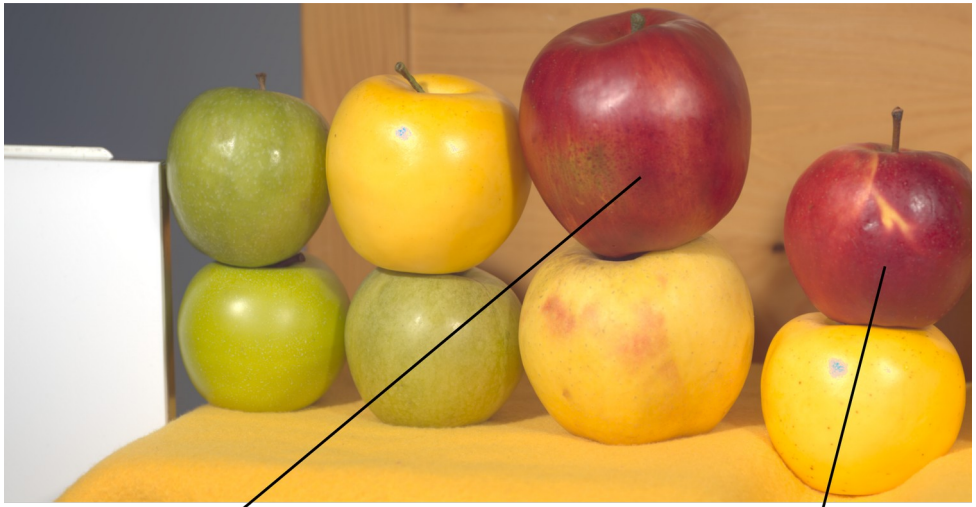


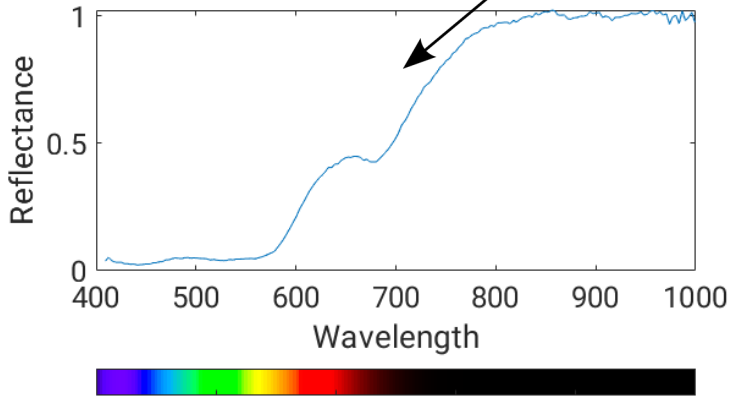

Spectral band contribution to class decision

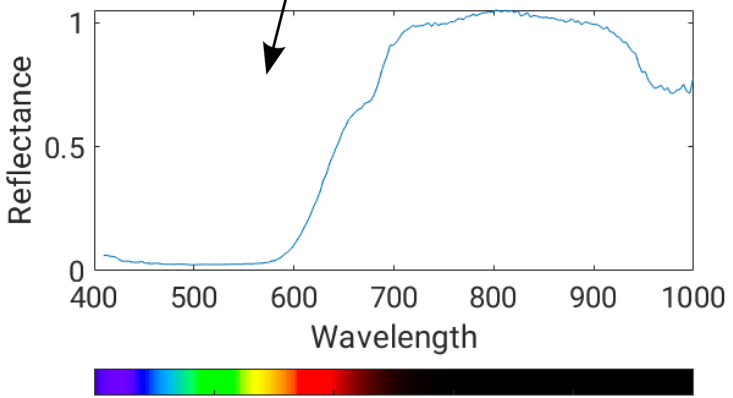
# Spectral Signature of Fruits

man-made apple

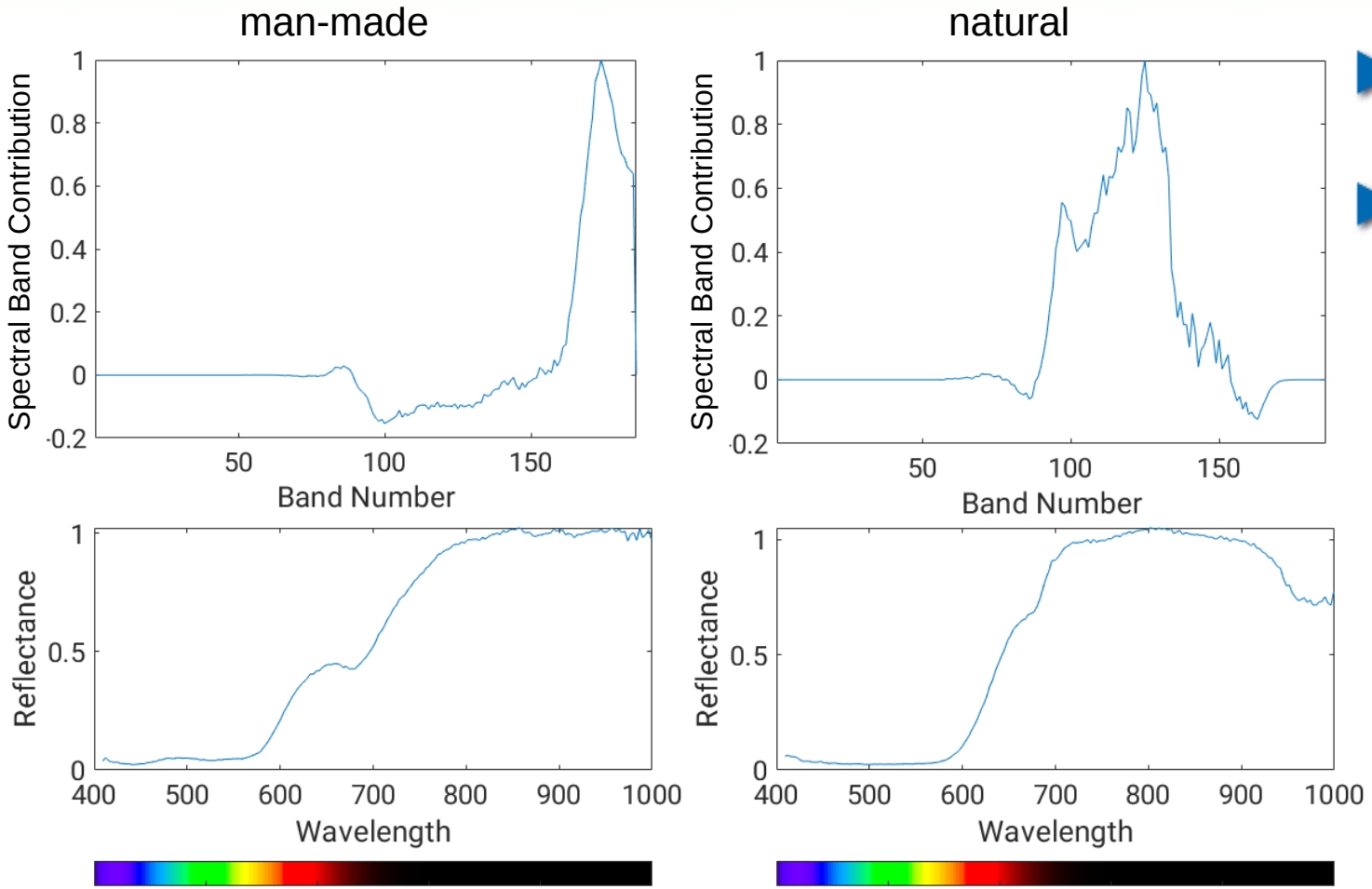


natural apple



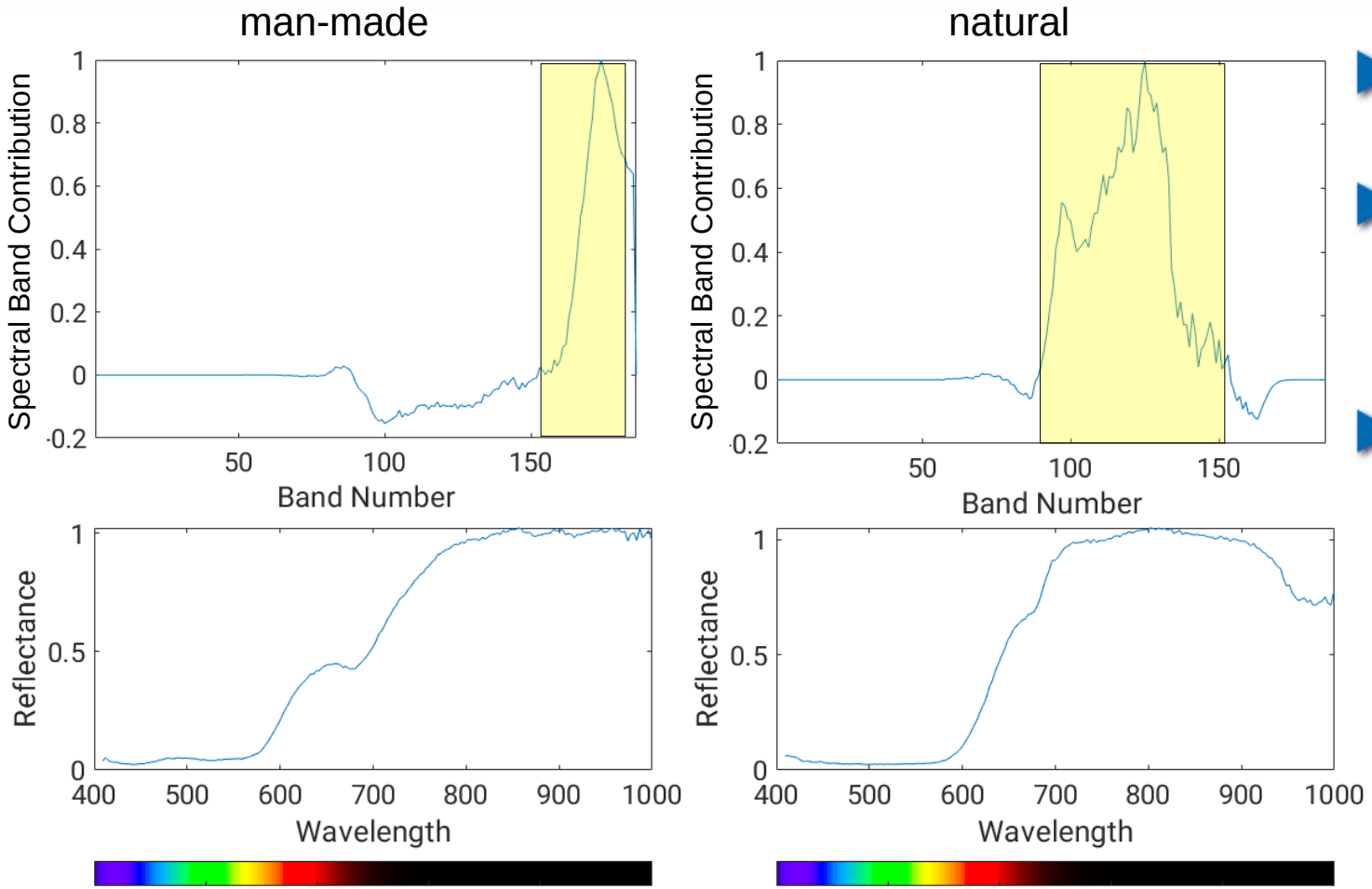



# Spectral Band Contribution to Class Decision




- **Training data**
  all fruits
- **Input value**
  HSI averaged

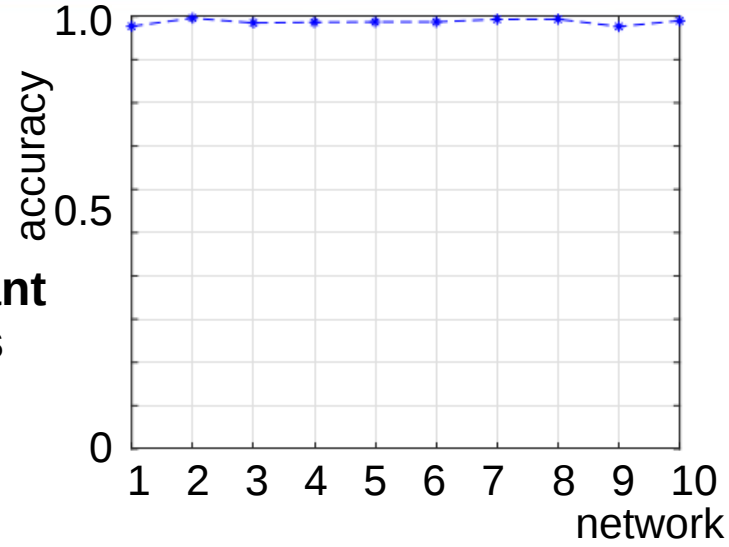
# Spectral Band Contribution to Class Decision

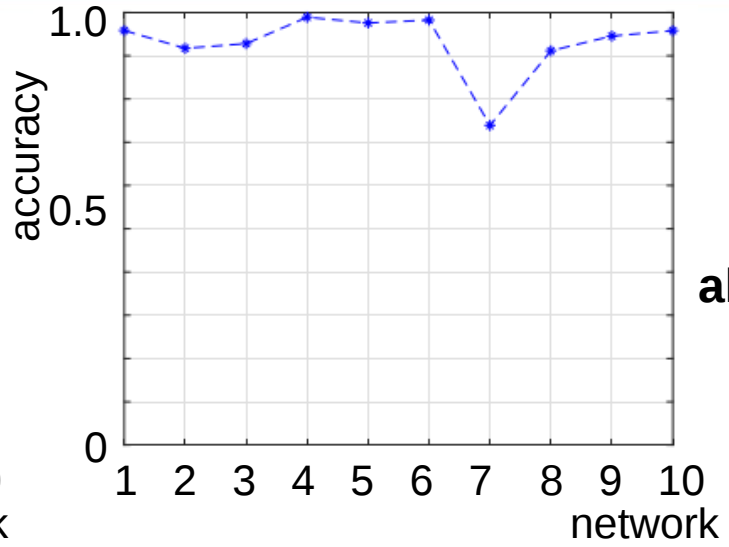



- **Training data**
  all fruits
- **Input value**
  HSI averaged
- **Relevant Bands for CNN**
  - 90 to 185
  - No visible range

# Test Accuracy of CNNs using Sparse Data

**relevant bands**



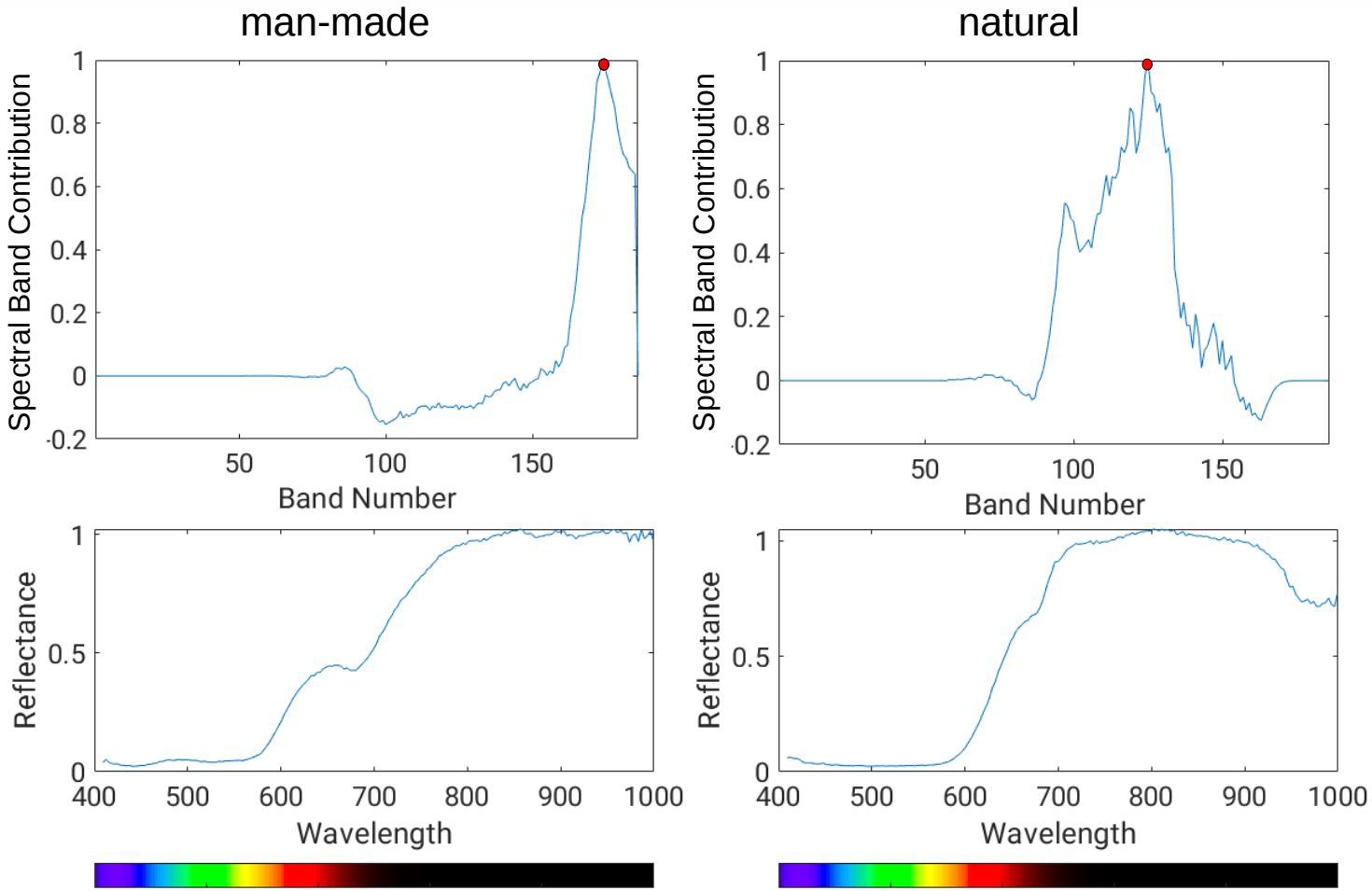




**all bands**

- **Training data**
  red and green apples
- **Test data**
  14 fruits
- **Input value**
  HSI pixelwise

- **Training of network parameters**
  10 times
- **CNN using relevant bands more stable**

# Relevant Spectral Bands for Spectrometers




- **Training data**
  all fruits
- **Input value**
  HSI averaged
- **Relevant Bands**
  174, 125

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# Two Spectrometers

RGB

R: Band 125
G: Band 174
B: Band 174

# Two Spectrometers

RGB

R: Band 125
G: Band 174
B: Band 174

# Conclusion

- Band reduction method using CNN
  for determination of relevant bands
- CNN finds spectral bands relevant to class decision

  → Spectrally constrained CNN
- Accuracy of relevant-band-CNN better than all-band-CNN
- Two most relevant bands are easily identified and work satisfyingly