H2I Workshop
Spectral Classifier for HSIs

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16/09/2021

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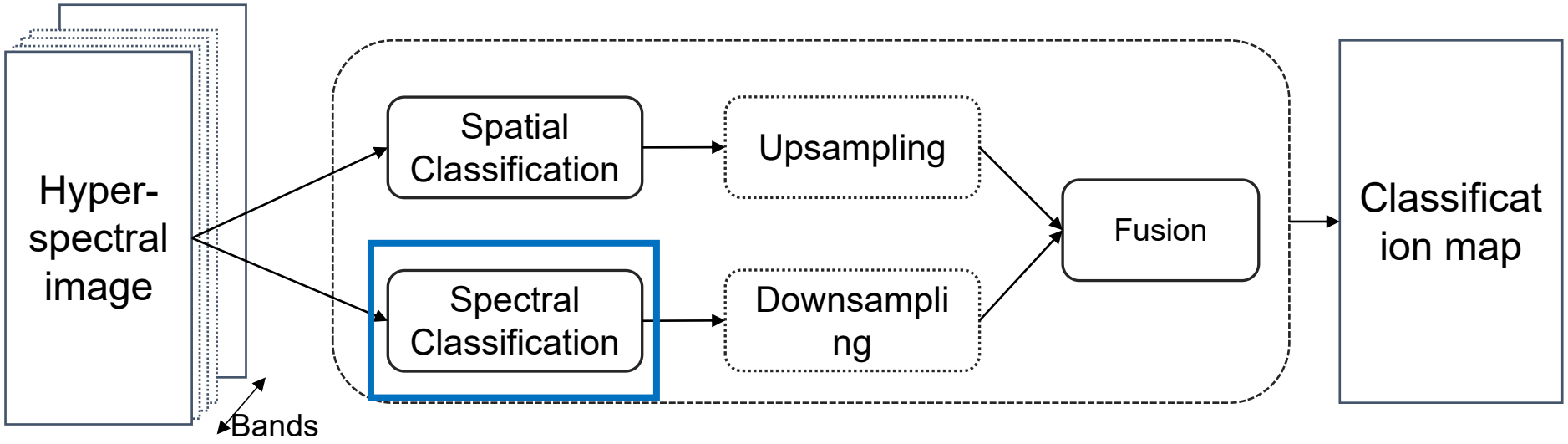
Outline

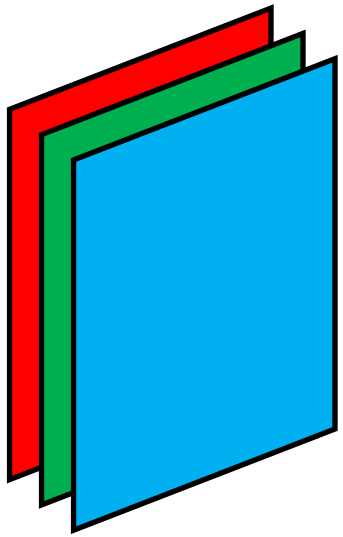
- Introduction to spectral classifier
- Classifier design and training
- Training platforms
- Classifier implementation in Pytorch

Introduction to spectral classifier

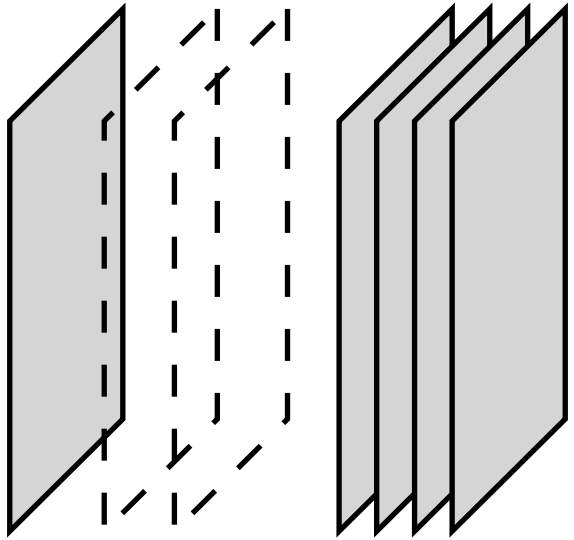


Introduction to spectral classifier

- RGB images vs HSIs



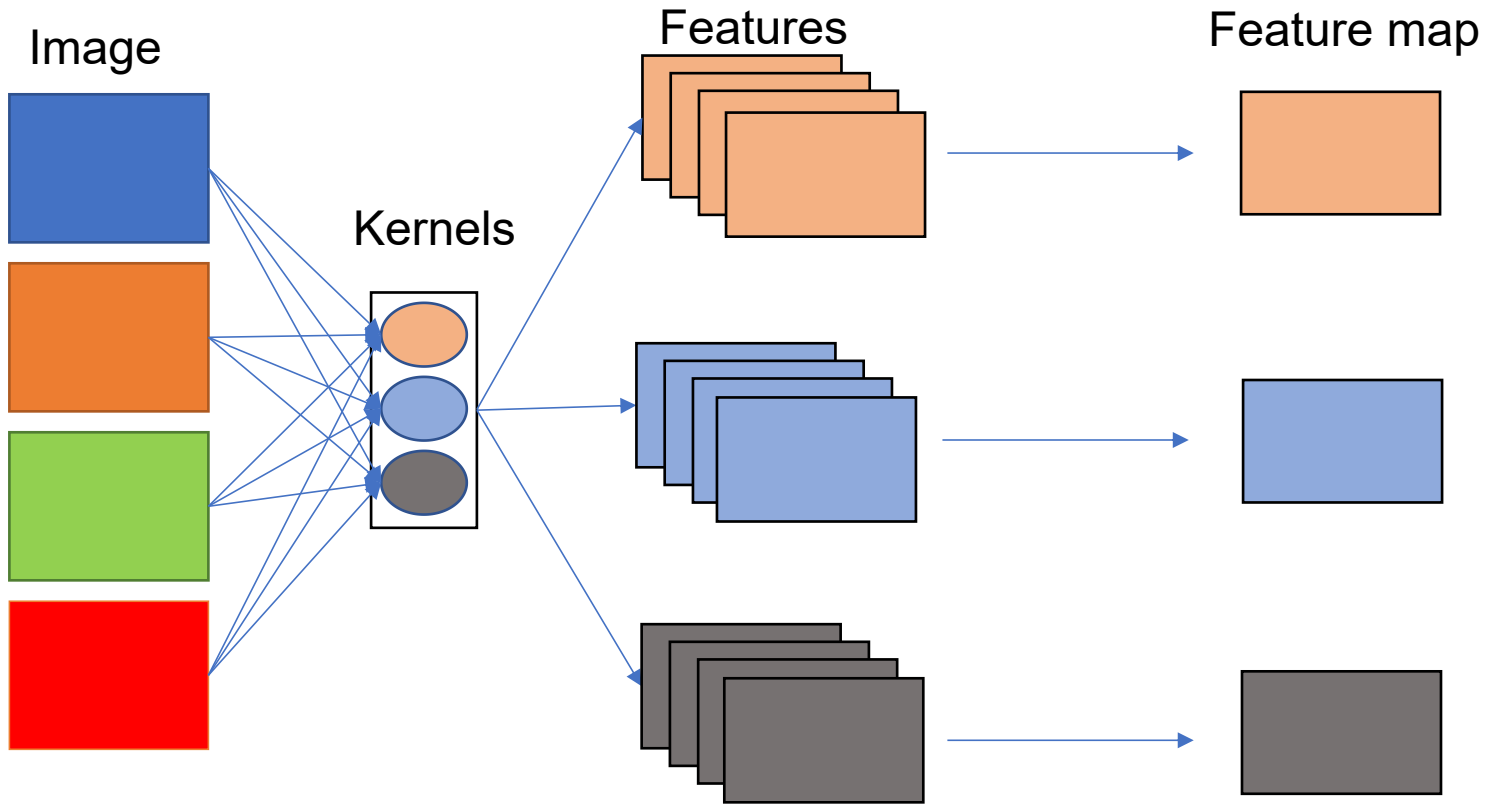
RGB image



HSIs

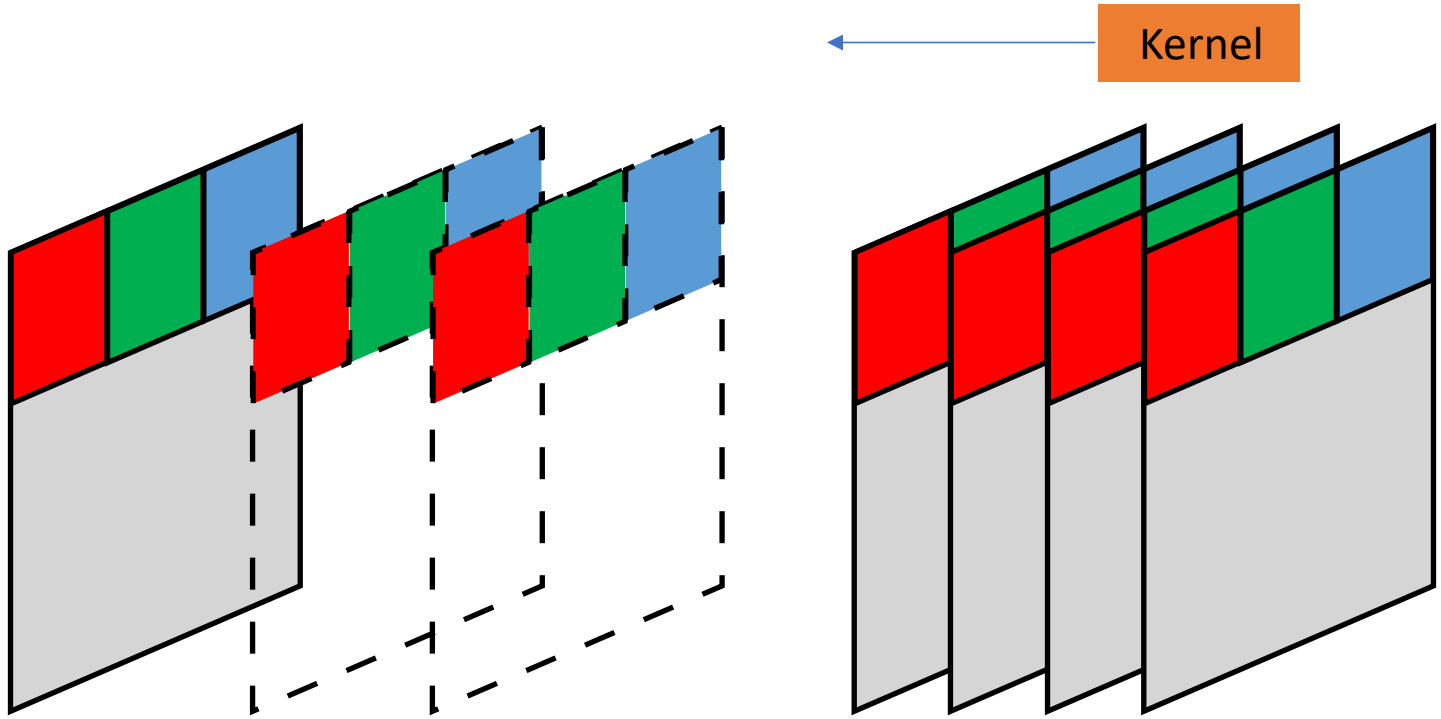
Introduction to spectral classifier

- Convolution in 2d



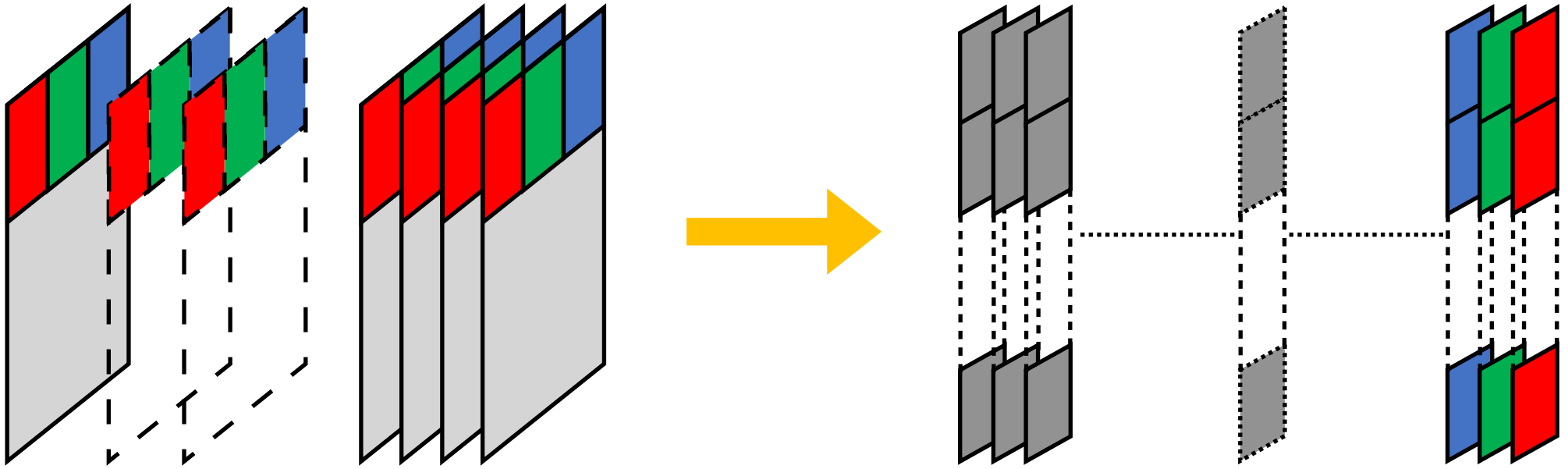
Introduction to spectral classifier

- Convolution in ‘3d’



Introduction to spectral classifier

- Data shape transformation

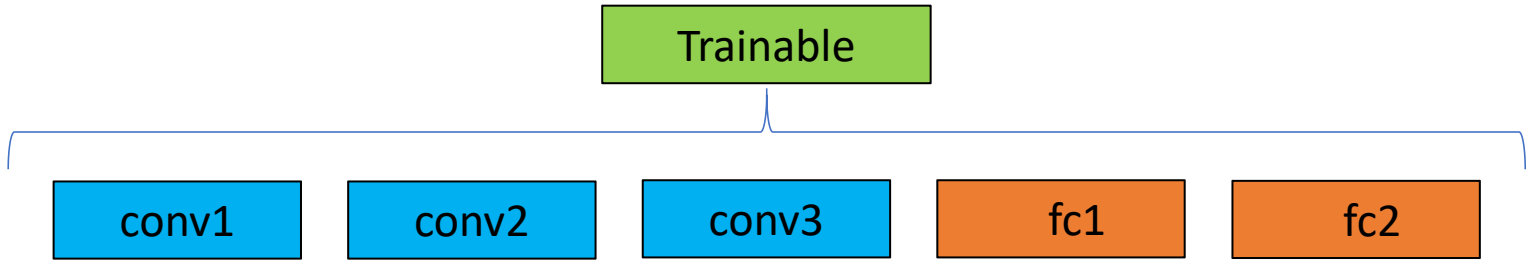


Classifier design and training

- Design
  - Use Cifar10Net architecture
  - Change parameters of Cifar10Net
    - Convolution kernel size
    - Pooling size
    - Input and output of fully connected layers

Training

- Direct training
  - Put all data together and fed to the network
  - Observation: imbalanced performance between categories



Training

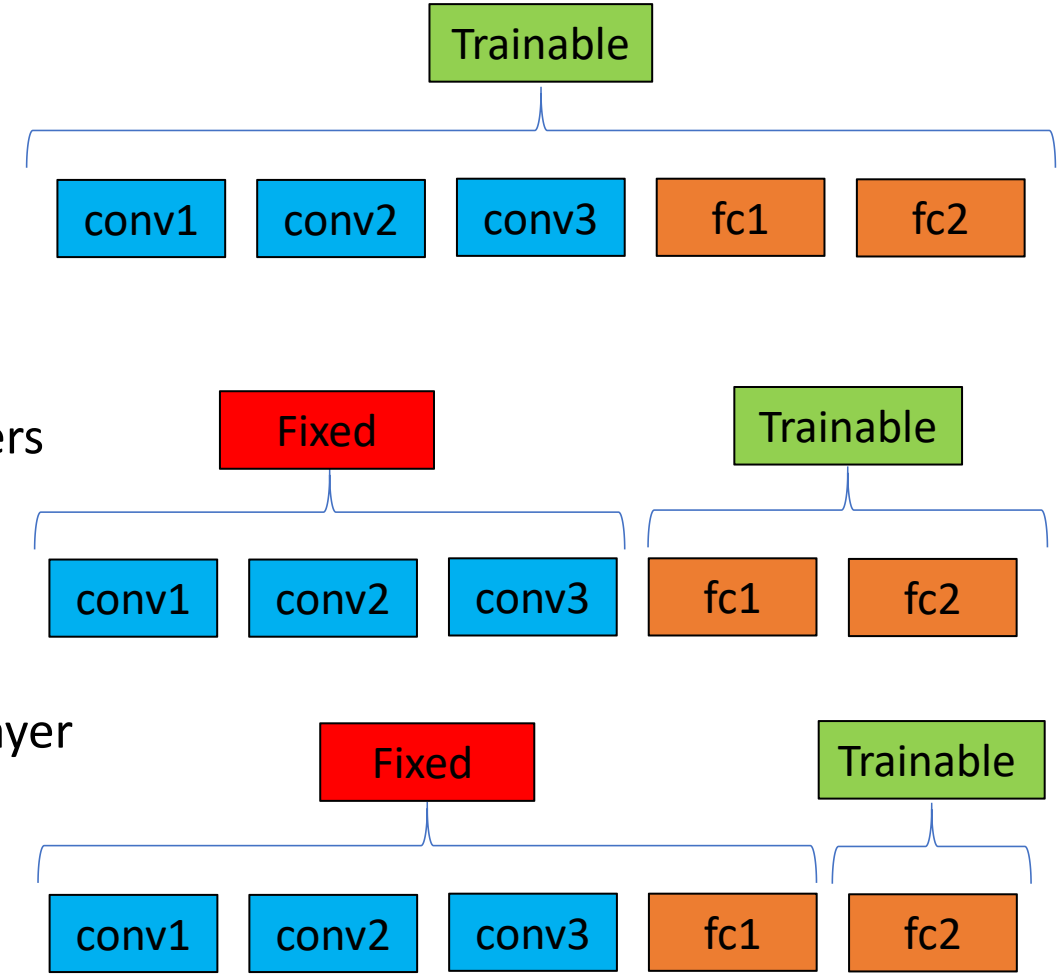
- Training by phases
    - Data selection and grouping
        - Group data by metric
        - 3 groups
    - Each phase trained by different data group
        - Train from scratch -> Finetune the network

Data selection and grouping

- Process training data process
    - Apply classifier to training data
    - Evaluate the outputs(probability) for training data
    - Group the data: Strong, Intermediate, Weak

Training by phases

- Phase 1:
  - Train the network from scratch
  - Data: Group strong feature
- Phase 2:
  - Finetune the network for 2 fully connected layers
  - Data: Group intermediate feature
- Phase 3:
  - Finetune the network for last fully connected layer
  - Data: Group weak feature



Training Platforms

- Pytorch: @Facebook, adapted from torch
- Tensorflow: @Google, integrated with Keras
- MxNet: @Apache Software Foundation
- CNTK: @Microsoft
- …

Training Platform

- Pytorch:

  The five steps in developing as follows:
  - 1. Prepare the Data
  - 2. Define the Model
  - 3. Train the Model
  - 4. Evaluate the Model
  - 5. Make Predictions

Prepare the Data

- Numerical input data and numerical output data
- Python libraries: numpy, pandas
- Pytorch build-in class: *DATASET* and *DATALOADER*

```
# dataset definition
class CSVDataset(Dataset):
    # load the dataset
    def __init__(self, path):
        # store the inputs and outputs
        self.X = ...
        self.y = ...

    # number of rows in the dataset
    def __len__(self):
        return len(self.X)

    # get a row at an index
    def __getitem__(self, idx):
        return [self.X[idx], self.y[idx]]
```

```
...
# create the dataset
dataset = CSVDataset(...)
# select rows from the dataset
train, test = random_split(dataset, [[...], [...]])
# create a data loader for train and test sets
train_dl = DataLoader(train, batch_size=32, shuffle=True)
test_dl = DataLoader(test, batch_size=1024, shuffle=False)
```

Define the Model

- Defines the layers of the model
- Define forward() function that defines how to forward propagate input through the defined layers of the model.
- Layers: Conv2d, Linear, Maxpool..

```
# model definition
class MLP(Module):
    # define model elements
    def __init__(self, n_inputs):
        super(MLP, self).__init__()
        self.layer = Linear(n_inputs, 1)
        self.activation = Sigmoid()

    # forward propagate input
    def forward(self, X):
        X = self.layer(X)
        X = self.activation(X)
        return X
```

Train the Model

- Define loss function
  - BCELoss: Binary cross-entropy loss for binary classification.
  - CrossEntropyLoss: Categorical cross-entropy loss for multi-class classification.
  - MSELoss: Mean squared loss for regression.
- Define optimization algorithm
  - SGD: stochastic gradient descent
  - Adam: A method for stochastic optimization

```
# define the optimization
criterion = MSELoss()
optimizer = SGD(model.parameters(), lr=0.01, momentum=0.9)
# enumerate epochs
for epoch in range(100):
    # enumerate mini batches
    for i, (inputs, targets) in enumerate(train_dl):
        ...
```

```
...
# clear the gradients
optimizer.zero_grad()
# compute the model output
yhat = model(inputs)
# calculate loss
loss = criterion(yhat, targets)
# credit assignment
loss.backward()
# update model weights
optimizer.step()
```

Evaluate the Model

- Prepare testing data
- Load the model
- Set the model into evaluation mode
- Evaluation
- Save the model

Make Predictions

- Prepare testing data
- Load the model
- Set the model into evaluation mode
- Evaluation

Classifier implementation in Pytorch

Thanks!

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