AI4EO

Special Topics in Applications (AIL861)
Artificial Intelligence for Earth Observation
Lecture 3

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Temporal considerations

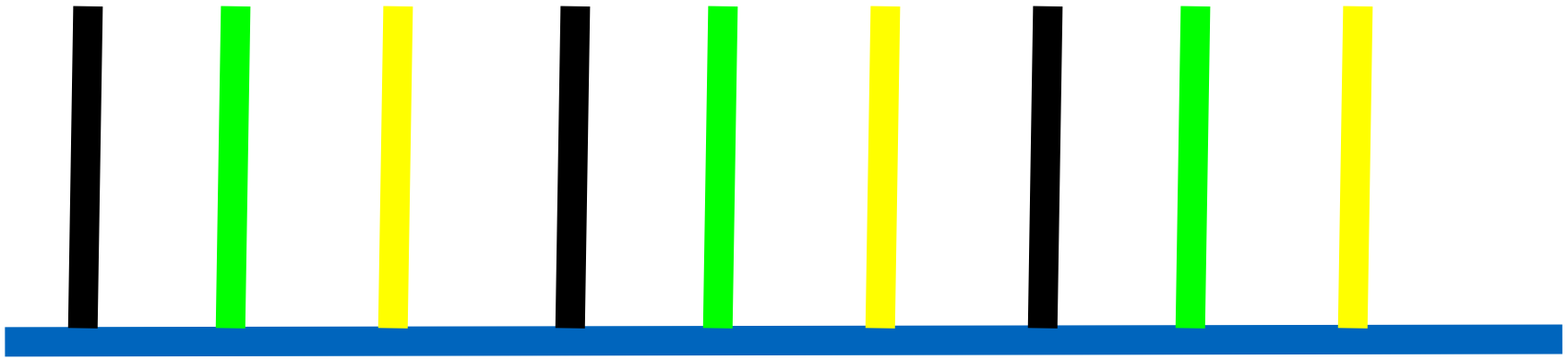
Temporal resolution

- ✔ Abrupt changes.
- ✔ Gradual changes.
- ✔ Sensor temporal resolution.

Challenges

- ✔ Challenge 10: both abrupt and gradual change detection.

Improving temporal resolution using multiple sensors



Time axis

Challenges

- ✔ Challenge 11: multi-sensor problem in time-series analysis.

Multi-domain data

Domain differences

Concept	In-domain	Target domain
Sensor	Sentinel-2	Worldview-2, Sentinel-1, …
Season	Summer	Winter, Autumn, Fall
Geography	Munich	HongKong, New York, …

Challenges

✔ Challenge 12: adapting to domains unseen during training.

Uncertainty

Out-of-distribution

Concept	In-domain	OOD
Sensor	Sentinel-2	Worldview-2, Sentinel-1, …
Season	Summer	Winter, Autumn, Fall
Geography	Munich	HongKong, New York, …
Open set	Water, forest	Building

Challenges

✔ Challenge 13: understanding when the model may fail with unseen data.

Different Learning Paradigms

Supervised Learning: 4 components

- ✔ Training data
- ✔ Learner
- ✔ Learning algorithm
- ✔ Performance

Supervised Learning: 4 components

- ✔ **Training data:** features, target/feedback
- ✔ **Learner:** parameters θ
- ✔ **Learning algorithm:** changes the parameters and improves performance
- ✔ **Performance**: cost function
- ✔ Predict - Score - Learn - …

Supervised Learning: various issues

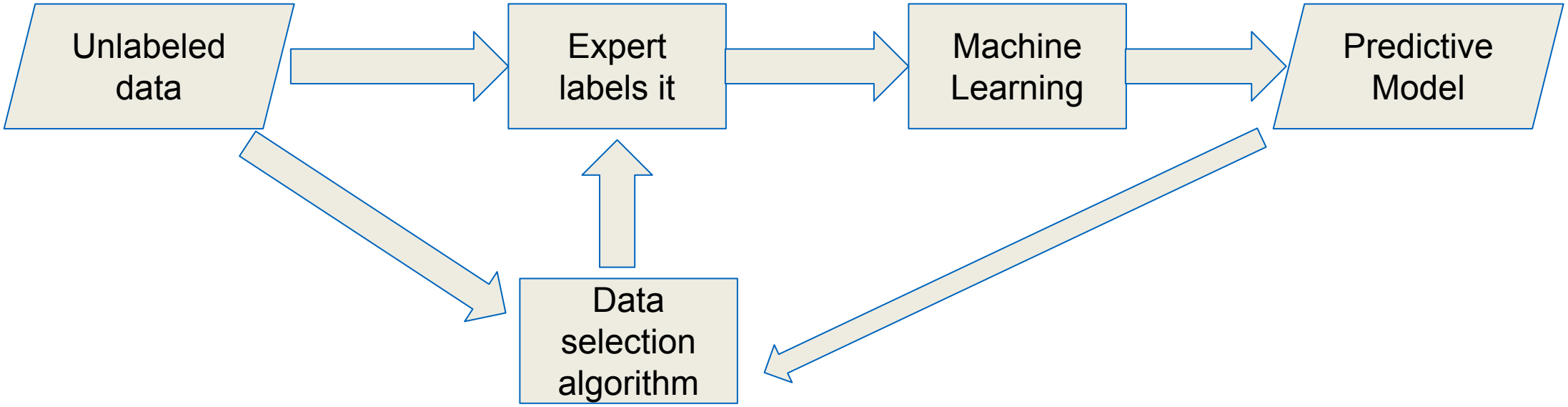
- ✔ Dependence on training data
- ✔ Less training data and less constraint - think of NN regression
- ✔ Apply constraint to make learning more meaningful - linear regression
- ✔ Overfitting and complexity (complex models overfit)

Dataset	Size
UC Merced	2100
AID	10000
Optimal-31	1860
RSSCN7	2800
Cifar-10	60000
Cifar-100	60000

Data Split

- ✔ Training
- ✔ Validation
- ✔ Test

Supervised Learning in Data-Efficient Manner: Active Learning



Different Learning Paradigms

- ✔ Supervised learning
- ✔ Semi-Supervised learning
- ✔ Unsupervised learning
- ✔ Self-supervised learning

Different Learning Paradigms

- ***Supervised learning*** – learning with labeled data
  - Approach: collect a large dataset, manually label the data, train a model, deploy
  - Learned feature representations on large datasets can be transferred via pre-trained models to smaller domain-specific datasets
- ***Unsupervised learning*** – learning with unlabeled data
  - Approach: discover patterns in data either via clustering similar instances, or density estimation, or dimensionality reduction …
- ***Self-supervised learning*** – representation learning with unlabeled data
  - Learn useful feature representations from unlabeled data through pretext tasks
  - The term “self-supervised” refers to creating its own supervision (i.e., without supervision, without labels)
  - Self-supervised learning is one category of unsupervised learning

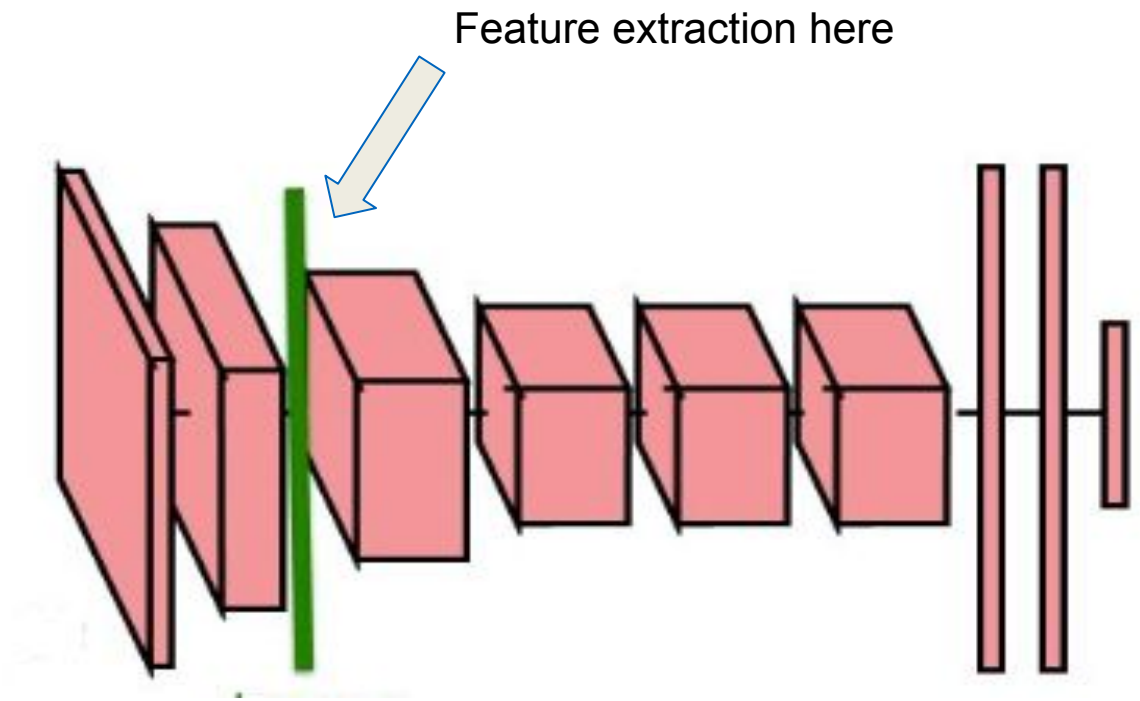
Using Models Trained in Supervised Fashion For Some Other Task

We have 3 choices

- ***Just use as feature extractor***
  - Just use the features extracted from particular layer(s) without any tuning
- ***Fine tuning on target data***
  - Further train particular layers of the network
- ***Unsupervised domain adaptation***
  - Adapt the network with unlabeled target data

Just use as a feature extractor

✔ Just use the features extracted from particular layer(s) without any tuning.



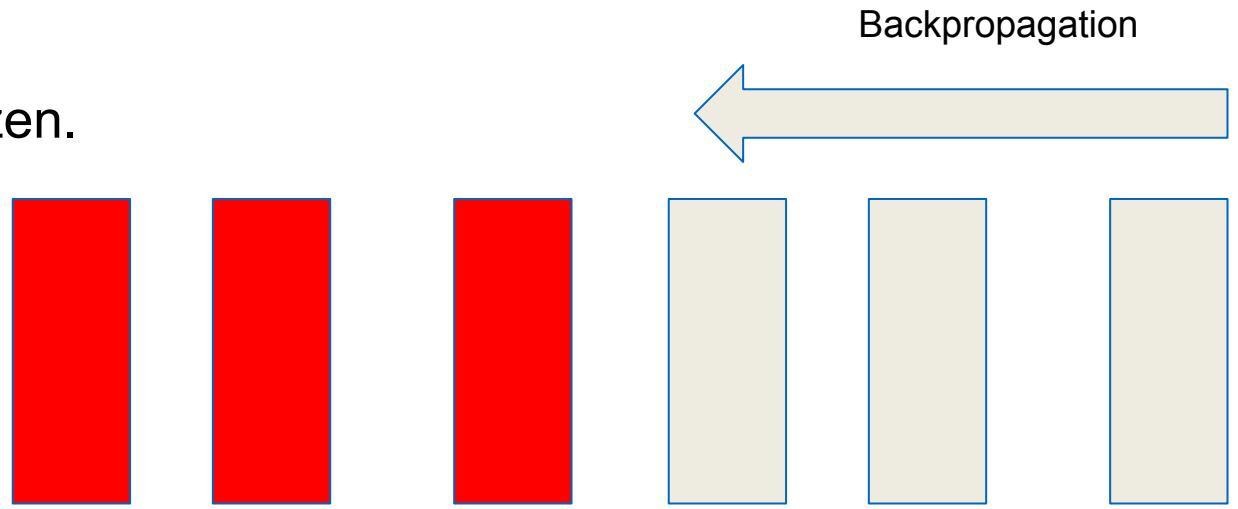
Challenges

- ✔ Which layer(s)?
- ✔ Do we have a validation dataset?
- ✔ Hypercolumn
- ✔ Can features from a particular layer be ranked?

Fine-tuning on target data

Further train particular layers of the network

Red layers are frozen.



Few-Shot Filtering for Change Detection