AIL 862

Lecture 22

Target Presence Detection

- Target detection is an important task in computer vision and Earth observation.

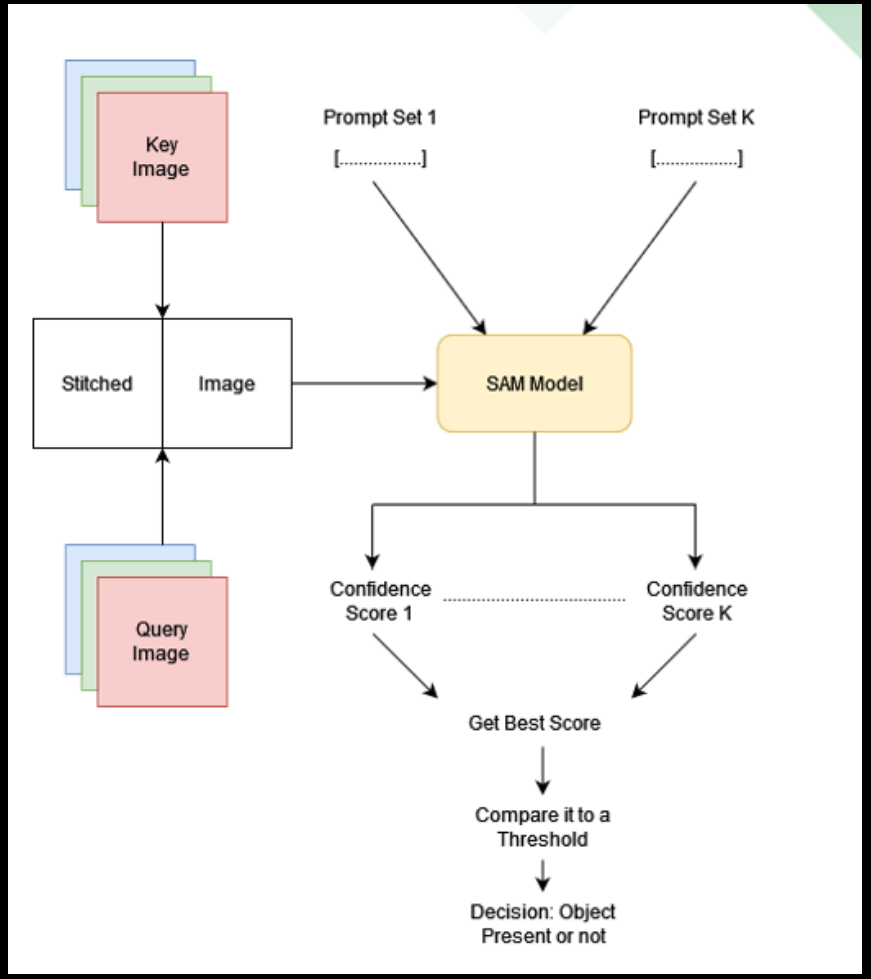
- Unlike traditional target detection problem that locates the object, target presence detection is about figuring out if a certain object or feature is in a scene.

- Especially helpful when the exact location isn't as important as knowing if the object is there.

Target Presence Detection

- ✓ Task: target presence detection.
- ✓ Learning paradigm: unsupervised.
- ✓ Number of example image: just one.

Target Presence Detection



Multi-Temporal Image Analysis

- Multi-temporal image analysis: Analysis of images of same object place acquired at different times.

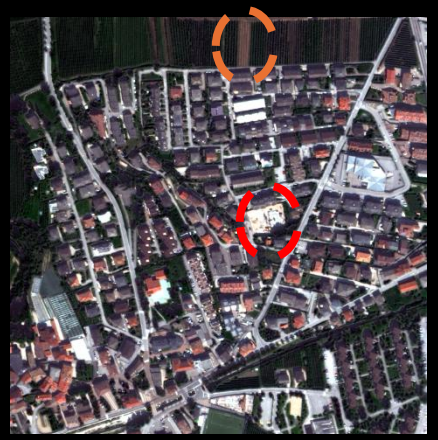
- Increased interest of multi-temporal image analysis over last decade due to:

❑Increased space mission -> better temporal resolution.

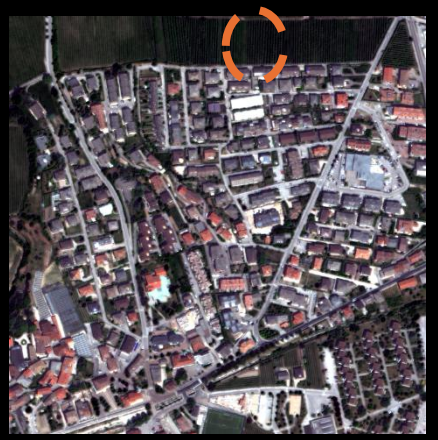
❑Free data access policy.

Change Detection

Pre-change



Post-change



Applications

Environmental monitoring

Infrastructure monitoring

Mining operations

Disaster management

Climate change

Agriculture

Planetary operations

Sensors

- Many modalities:

❑Multi-spectral

❑Hyperspectral

❑Synthetic Aperture Radar (single band, polarimetric)

- Additionally, different resolutions.

Supervision

- There are supervised methods, e.g., based on Siamese networks.
- Difficult to collect large-scale multi-temporal labeled datasets.
- Several issues with labeled datasets, including generalization to new tasks/areas.
- Sometimes impractical, e.g., in disaster management.

- So, unsupervised methods are preferred.

Traditional Unsupervised Methods

- Differencing (Change Vector Analysis – CVA and variants) or clustering:
  - ❑ Pixel values
  - ❑ Shallow features computed from pixels

- Object based notions: super-pixels

- Higher resolution – higher spatial complexity

- Limited capability to capture spatial context and temporal complexity.

Deep CVA (2018)

- A CD method employing CNN for VHR optical bi-temporal images for single-sensor scenario

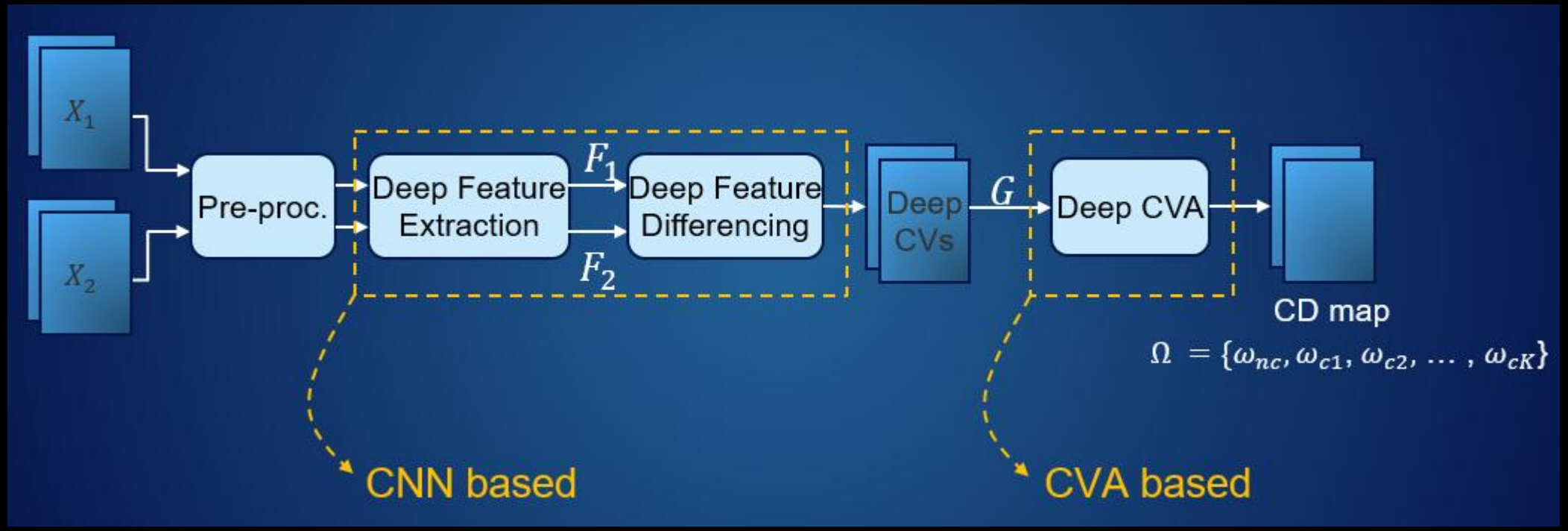
- Given input bi-temporal VHR images acquired using the same sensor, to devise CD techniques to:

❑Distinguish changed pixels from the unchanged ones (binary CD)

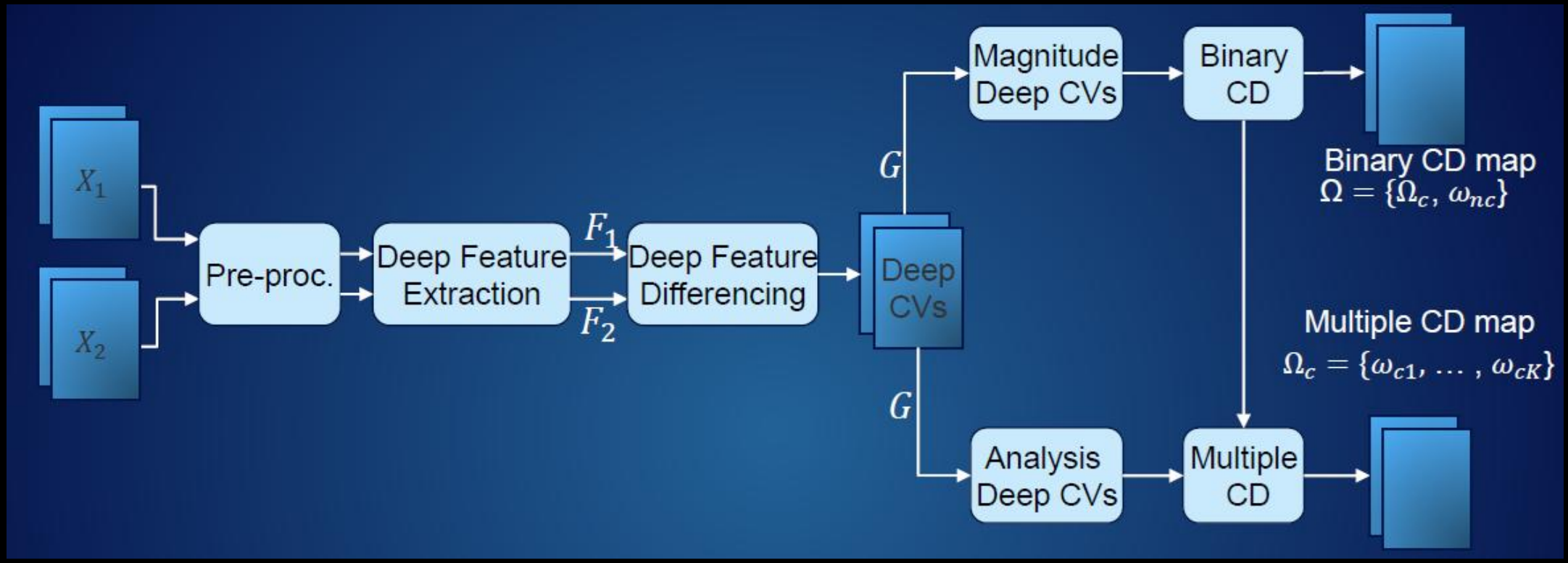
❑Further segregate changed pixels into different kinds of changes (multiple CD)

- Assumption: We have a network trained on VHR optical images, for classification or segmentation

Deep CVA


X_1
X_2
Pre-proc.
Deep Feature Extraction
F_1
F_2
Deep Feature Differencing
Deep CVs
G
Deep CVA
CD map
$\Omega = \{\omega_{nc}, \omega_{c1}, \omega_{c2}, \dots, \omega_{cK}\}$
CNN based
CVA based

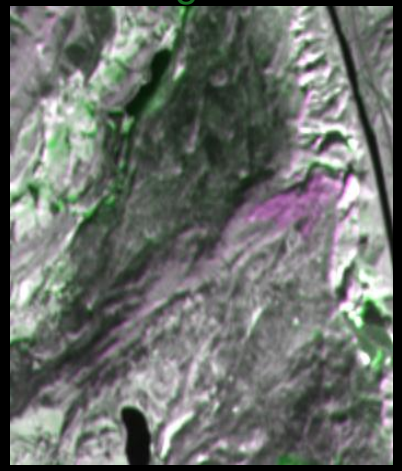
Deep CVA


X_1
X_2
Pre-proc.
Deep Feature Extraction
F_1
F_2
Deep Feature Differencing
Deep CVs
G
G
Magnitude Deep CVs
Binary CD
Binary CD map
$\Omega = \{\Omega_c, \omega_{nc}\}$
Multiple CD map
$\Omega_c = \{\omega_{c1}, \ldots, \omega_{cK}\}$
Analysis Deep CVs
Multiple CD

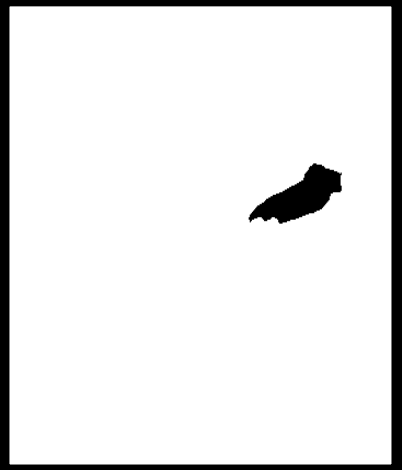
Deep CVA – using for other sensors

Visual Result on Sentinel-2 Images

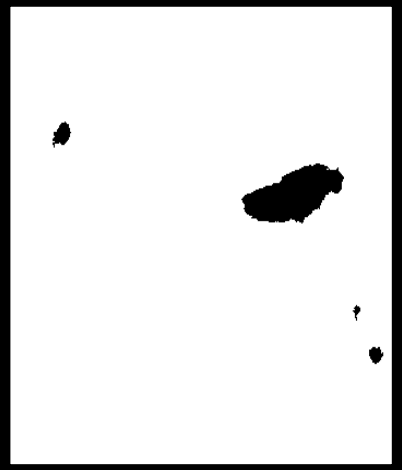
Multitemporal FCC (SWIR)
Pre-change: 23/02/2019
Post-change: 03/03/2019



Reference map



DCVA



RCVA (SWIR)

RCVA (NIR)