Change Event Dataset for Discovery from Spatio-temporal Remote Sensing Imagery

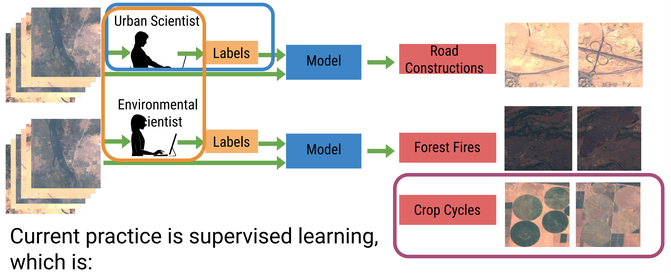
Cornell Bowers C·IS
College of Computing and Information Science

Utkarsh Mall Bharath Hariharan Kavita Bala
Cornell University

NEURAL INFORMATION PROCESSING SYSTEMS

Problem

We need tools to **discover** and **quantify** interesting events.



Current practice is supervised learning, which is:

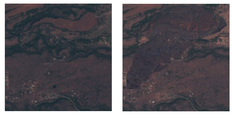
Costly Application specific Cannot discover the unknown

Contributions

A **self-supervised** method to discover **change events** from spatio-temporal satellite imagery.
Two new benchmarks for change event **retrieval** and **clustering** created using this method.

CaiRoad Benchmark

CalFire Benchmark



Change Events

Definition: a group of pixels over space and time that were changed by a single event

$$V \in R^{l \times x \times y \times c}$$

$$\langle V_{1 \cdots l}, C_{1 \cdots l-1} \rangle$$

$$C \in \{0,1\}^{l-1 \times x \times y}$$

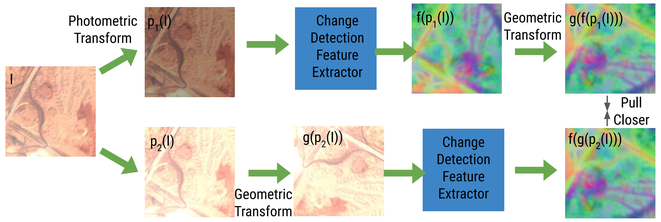
l: temporal span x, y: spatial span of events c: *number of bands*

Discovering Change Events

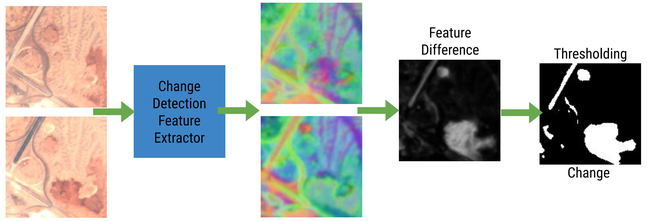
Self-supervised Change Detection

Training: Learning pixel-level features

Invariant to *photometric* transforms & **Equivariant** to *geometric* transforms



Inference: thresholding feature differences



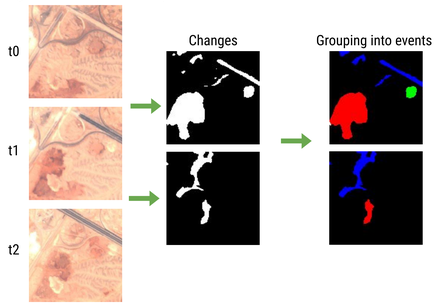
Change Grouping

Grouping pixels using their:

Spatio-temporal properties & Visual features

$$(d_x(v_1, v_2) + c_t d_t(v_1, v_2) < \delta_{st}) \wedge (d_f(v_1, v_2) < \delta_f)$$

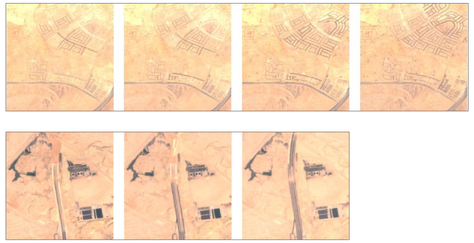
Changes over multiple time steps



Benchmarks

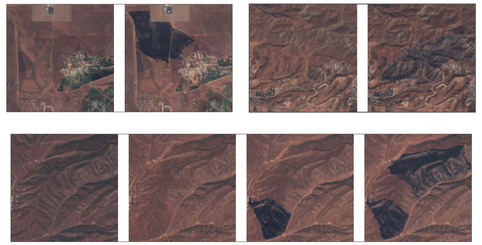
CaiRoad Benchmark
28015 Total Events
2256 Road Construction Events

Examples of Road Constructions



CalFire Benchmark
2172 Total Events
204 Forest Fire Events

Examples of Forest Fires



Event annotations done using semi-automatic methods.

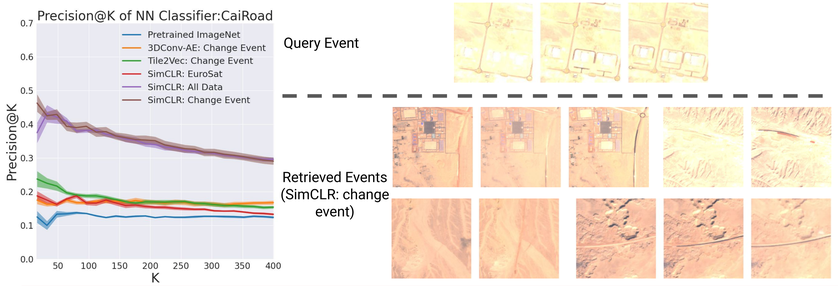
- Automatically produce approximate labels using publicly available metadata about events [1, 2].
- Second step of human verification using Prolific.

Applications

We learn a representation for change events using self-supervised methods.

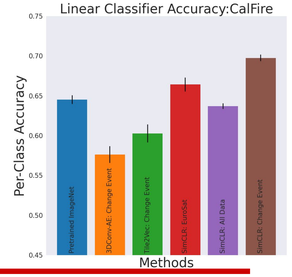
Change Event Retrieval

This representation can be used to retrieve similar events.



Change Event Classification

It can also be used to train event classifiers.



Takeaways

Change events can be used to quantify interesting phenomena such as constructions or natural disasters.

More work is required in the future to accurately represent change events.

References

[1] CalFire: https://www.fire.ca.gov/incidents/
[2] CaiRoad: https://www.openstreetmap.org/

Acknowledgment

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