Remote-Sensing and Environmental Data Fusion for Wildfire Propagation Prediction via CNN-Segmentation and Pixel-Based Enhanced Support Vector Machine

InfernotiX

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Motivation

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Challenge in **Estimating Wildfire Behavior:**

Complex interplay of various factors

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Challenging in both **spatially** and **temporally**

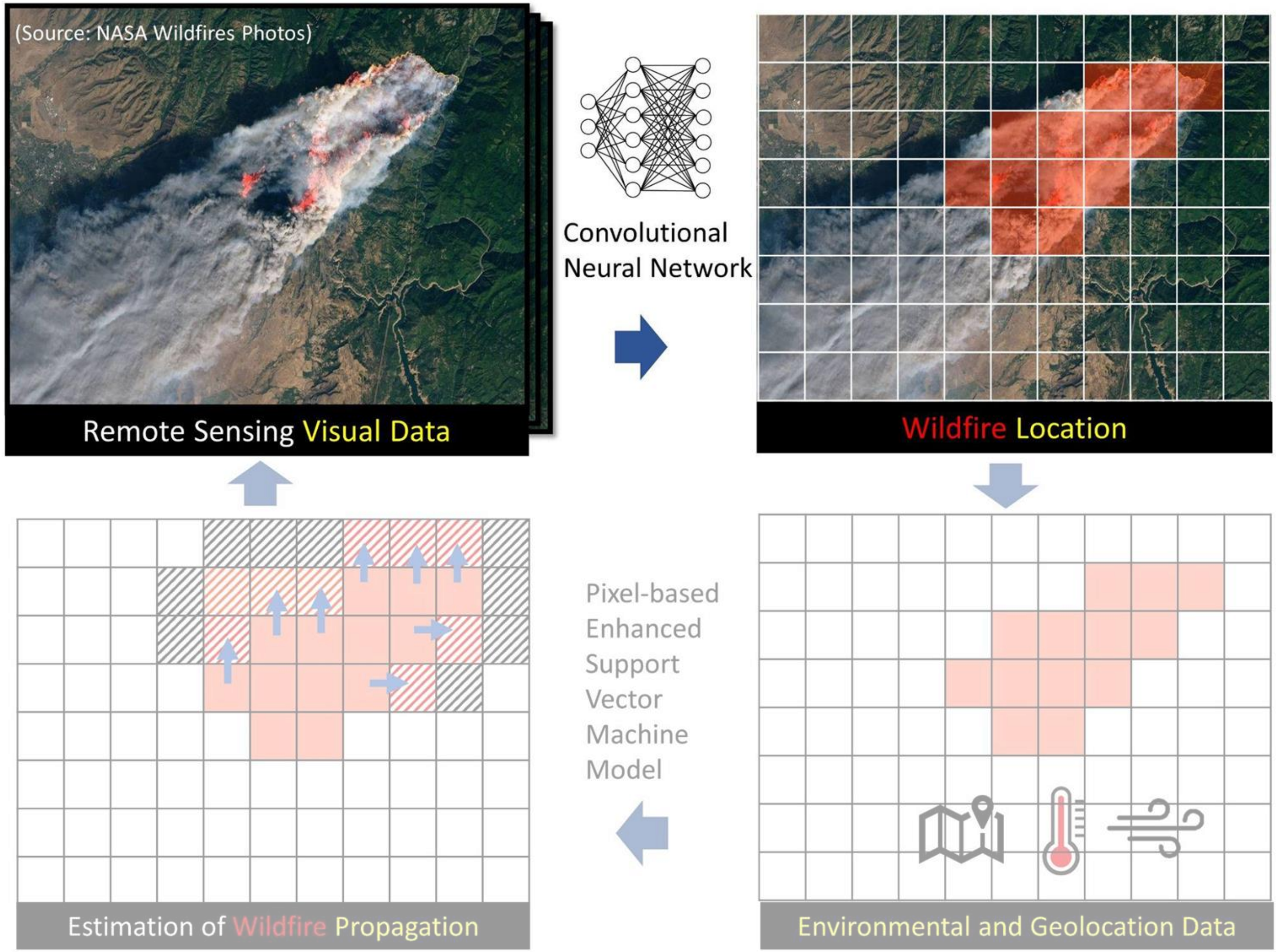
Opportunity

Advanced in Artificial Intelligence (AI) and Remote Sensing

Gap

AI for **wildfire detection** and **propagation estimation** remains an under-explored area.

Proposed Approach



Deep Learning-based Wildfire Detection

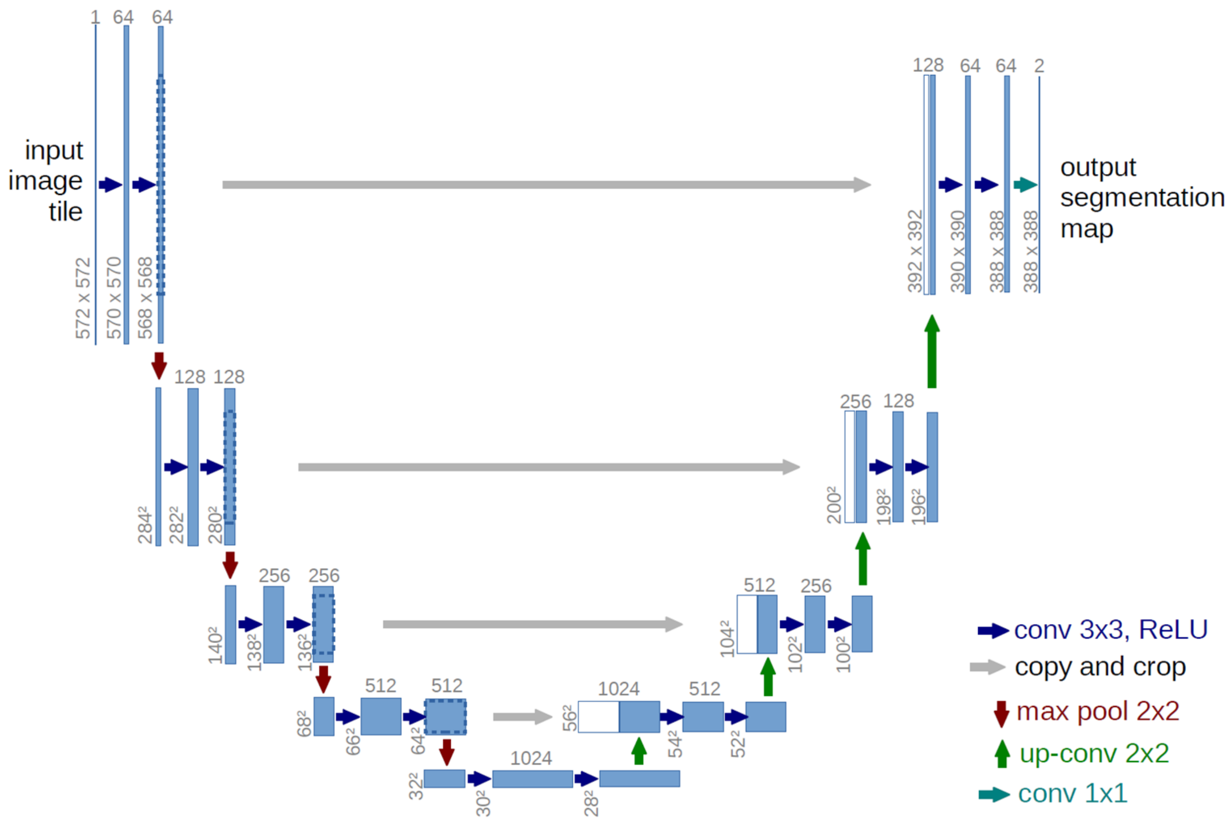
Model: U-Net

Training Set:

Annotated Active Fire Dataset*

Data Augmentation:

Images are divided into patches of 256 pixels by 256 pixels.

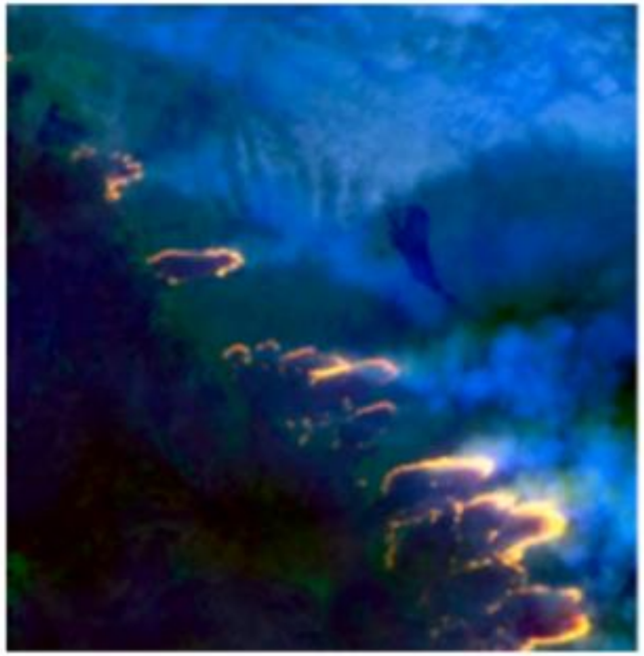


The architecture of U-Net model

*(containing 8,194 satellite images of wildfires over the world taken by a NASA/USGS operated satellite Landsat-8 between 2020 and 2022)

The results for deep learning-based wildfire detection model:

Metric	Value
Precision	86.8%
Recall	89.7%
IoU	78.9%



Sample input image

Sample detection results

Proposed Approach

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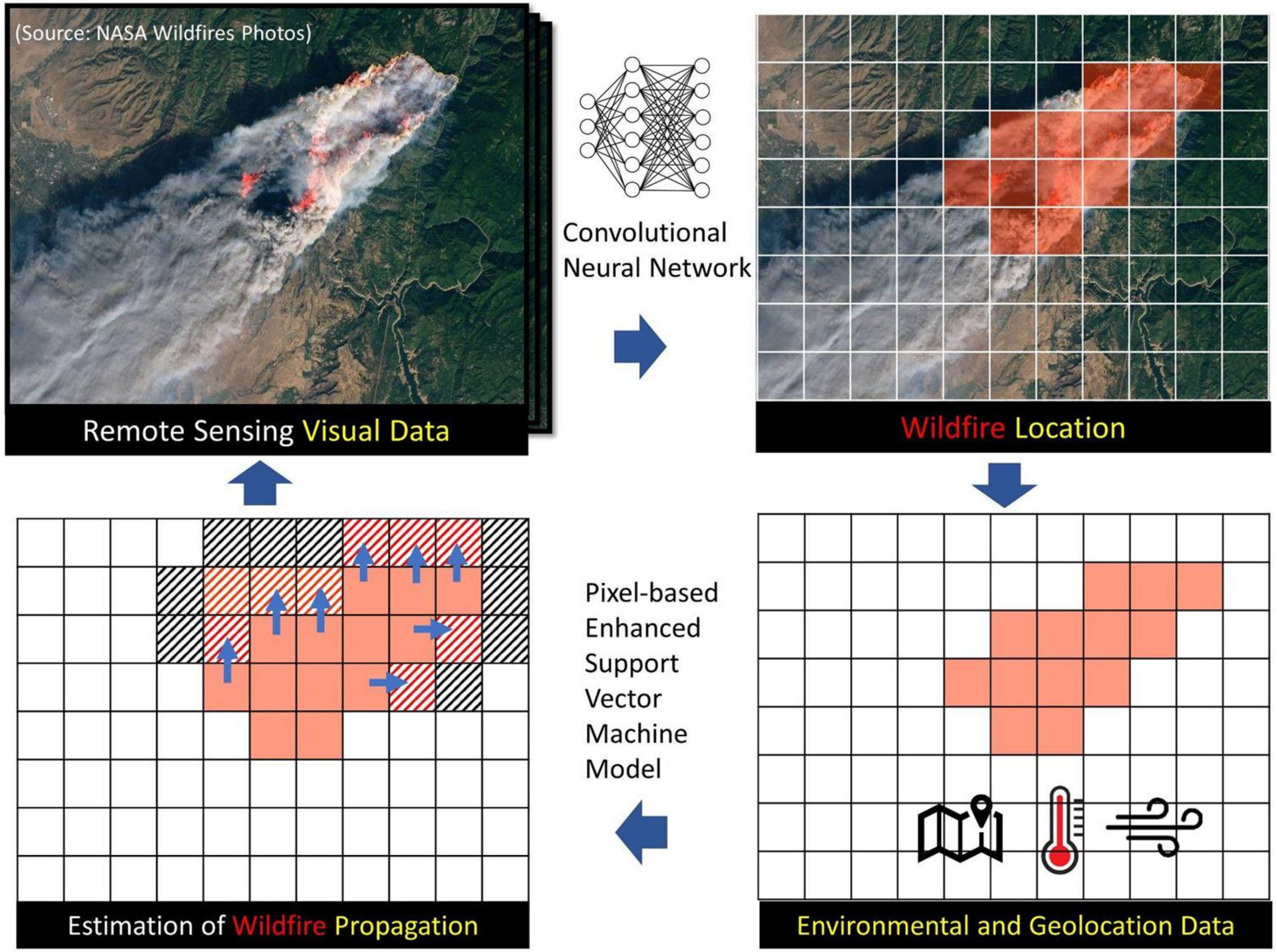

- Location
- Intensity
- Combustible materials

- Temperature
- Precipitation
- Humidity
- Wind

Case Study – Nebo Fire Dataset

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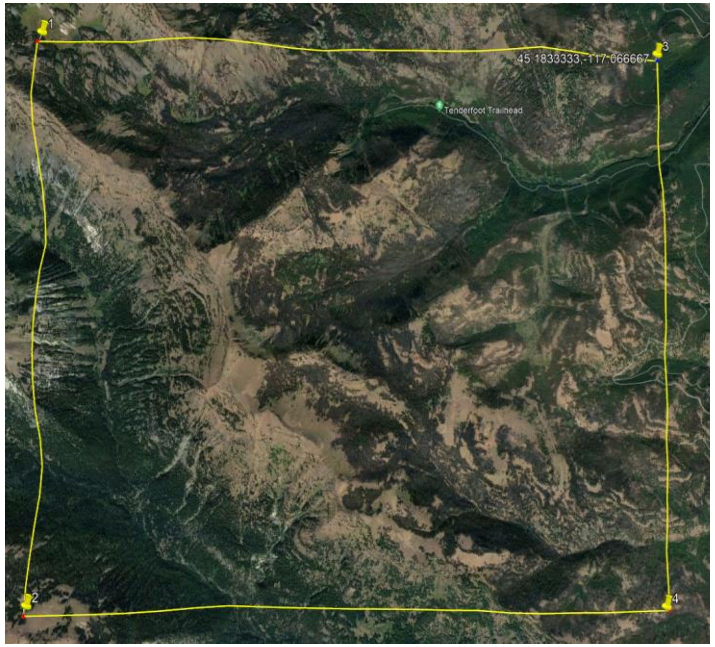
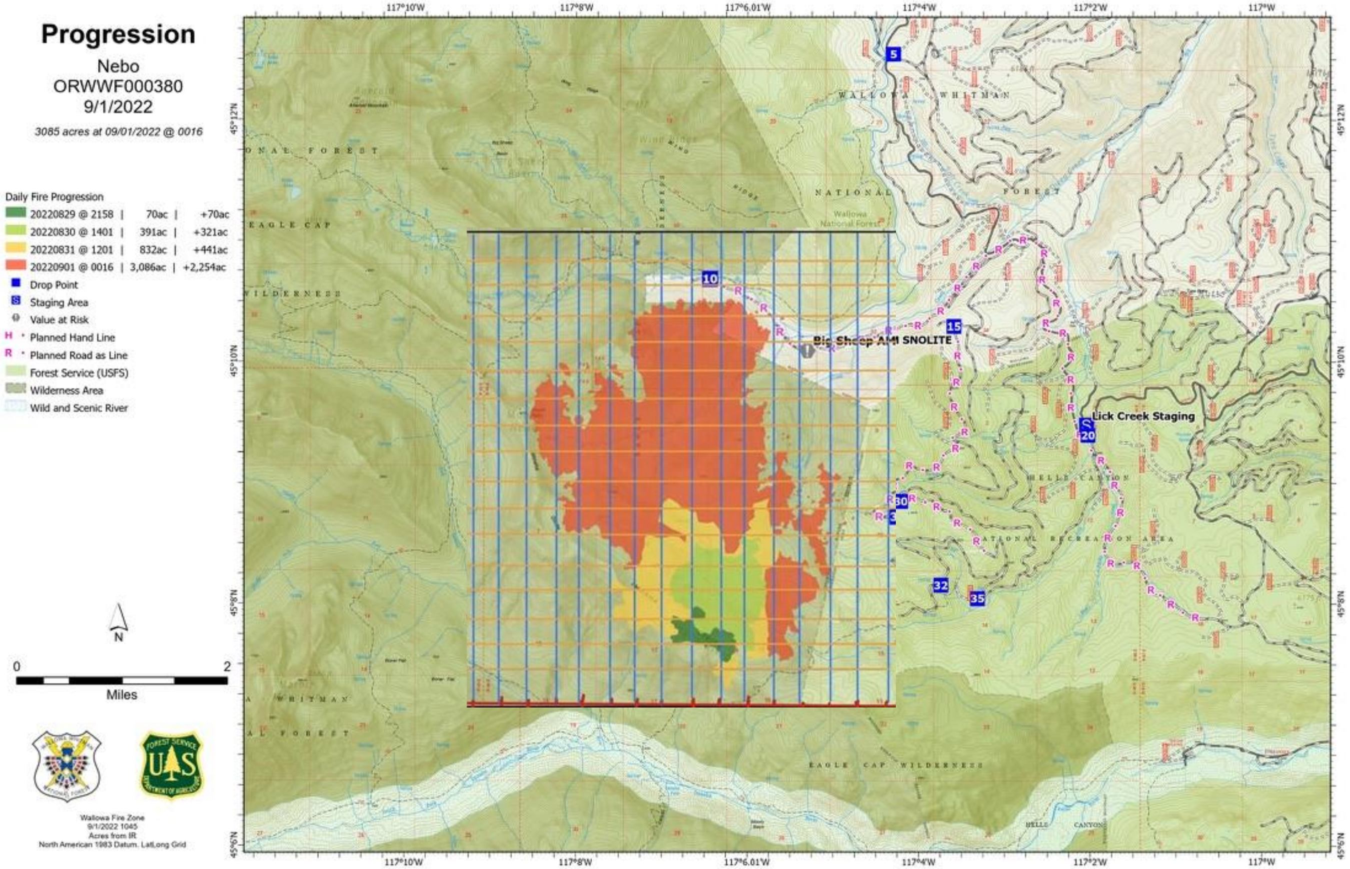
Progression report for the fire

(08/29/2022 – 09/01/2022)

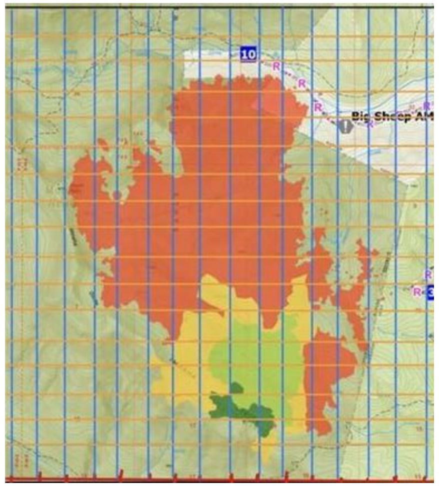


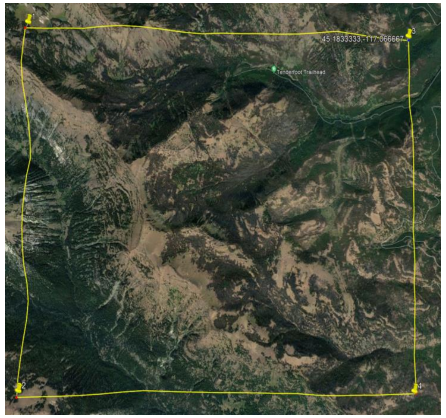
Google Map in the fire area



Nebo Fire, OREGON

Case Study – Nebo Fire Dataset





Nebo fire

- Longitude
- Latitude
- Altitude

- Boundary
- Intensity

(FIRMS US/CANADA)

(NRT VIIRS 375 m)

- Temperature
- Precipitation
- Humidity
- Wind

- Combustible material

Longitude	Latitude	ltitude (m	rned_befo	Fuel_mat	Tem_high	Tem_low	Tem_avg	recipitatio	Wind(mph	Dew_point	levelpress	B1	B2	FRP	um_day_fi	rned_Result
-117.133	45.1233	1751	0	1	86	62	69.6	0	8	64.92	27.8	200	200	0	6	0
-117.127	45.1233	1823.9	0	1	86	62	69.6	0	8	64.92	27.8	200	200	0	6	0
-117.121	45.1233	1876.9	0	1	86	62	69.6	0	8	64.92	27.8	200	200	0	6	0
-117.116	45.1233	1887.5	0	1	86	62	69.6	0	8	64.92	27.8	200	200	0	6	0
-117.11	45.1233	1912.4	0	2	86	62	69.6	0	8	64.92	27.8	200	200	0	6	0
-117.104	45.1233	1930.2	0	2	86	62	69.6	0	8	64.92	27.8	200	200	0	6	0
-117.099	45.1233	1976.5	0	2	86	62	69.6	0	8	64.92	27.8	200	200	0	6	0
-117.093	45.1233	2056.8	0	2	86	62	69.6	0	8	64.92	27.8	200	200	0	6	0
-117.087	45.1233	2173.9	0	2	86	62	69.6	0	8	64.92	27.8	200	200	0	6	0
-117.082	45.1233	2124.9	0	3	86	62	69.6	0	8	64.92	27.8	200	200	0	6	0
-117.133	45.127	1882.1	0	1	86	62	69.6	0	8	64.92	27.8	200	200	0	6	0
-117.127	45.127	1927.5	0	1	86	62	69.6	0	8	64.92	27.8	200	200	0	6	0
-117.121	45.127	1978.5	0	1	86	62	69.6	0	8	64.92	27.8	200	200	0	6	0
-117.116	45.127	2023.6	0	1	86	62	69.6	0	8	64.92	27.8	200	200	0	6	0
-117.11	45.127	2090.5	0	1	86	62	69.6	0	8	64.92	27.8	200	200	0	6	0
-117.104	45.127	2099.9	0	1	86	62	69.6	0	8	64.92	27.8	200	200	0	6	0
-117.099	45.127	2149	0	2	86	62	69.6	0	8	64.92	27.8	200	200	0	6	1
-117.093	45.127	2132.4	0	2	86	62	69.6	0	8	64.92	27.8	200	200	0	6	0
-117.087	45.127	2085.3	0	2	86	62	69.6	0	8	64.92	27.8	200	200	0	6	0
-117.082	45.127	2088.2	0	2	86	62	69.6	0	8	64.92	27.8	200	200	0	6	0
-117.133	45.1306	1965	0	1	86	62	69.6	0	8	64.92	27.8	200	200	0	6	0
-117.127	45.1306	1961	0	1	86	62	69.6	0	8	64.92	27.8	200	200	0	6	0
-117.121	45.1306	2126	0	2	86	62	69.6	0	8	64.92	27.8	200	200	0	6	0
-117.116	45.1306	2166.5	0	1	86	62	69.6	0	8	64.92	27.8	200	200	0	6	0
-117.11	45.1306	2283.5	1	1	86	62	69.6	0	8	64.92	27.8	334.61	296.1	8.11	6	1
-117.104	45.1306	2263	0	1	86	62	69.6	0	8	64.92	27.8	200	200	0	6	1
-117.099	45.1306	2222.8	0	1	86	62	69.6	0	8	64.92	27.8	200	200	0	6	1
-117.093	45.1306	2192	0	2	86	62	69.6	0	8	64.92	27.8	200	200	0	6	0

Results of Wildfire Prediction

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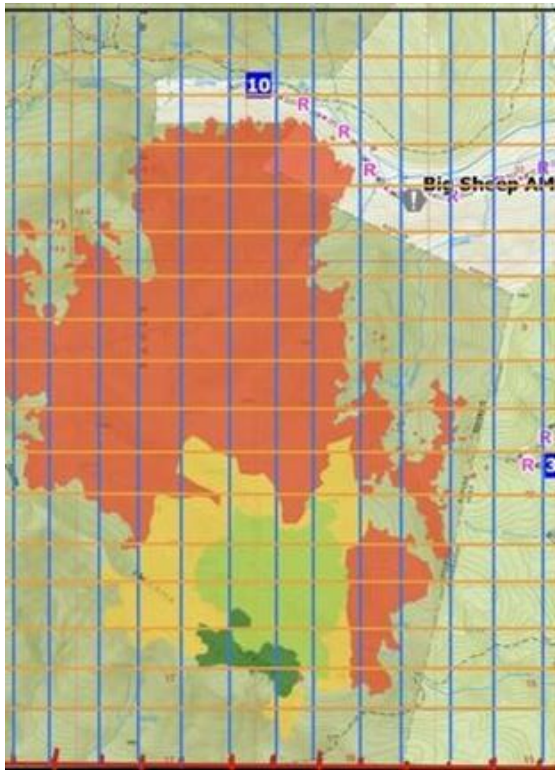
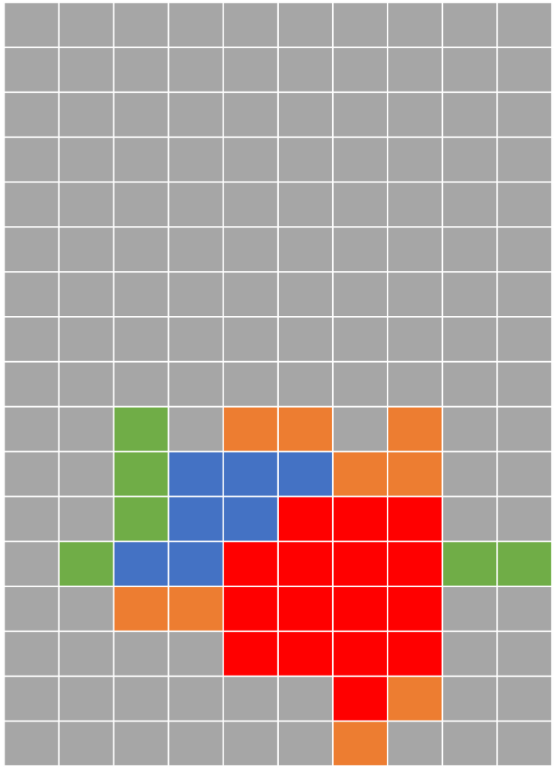
Pixel-based Enhanced Support Vector Machine Model (PESVM):

Ground Truth

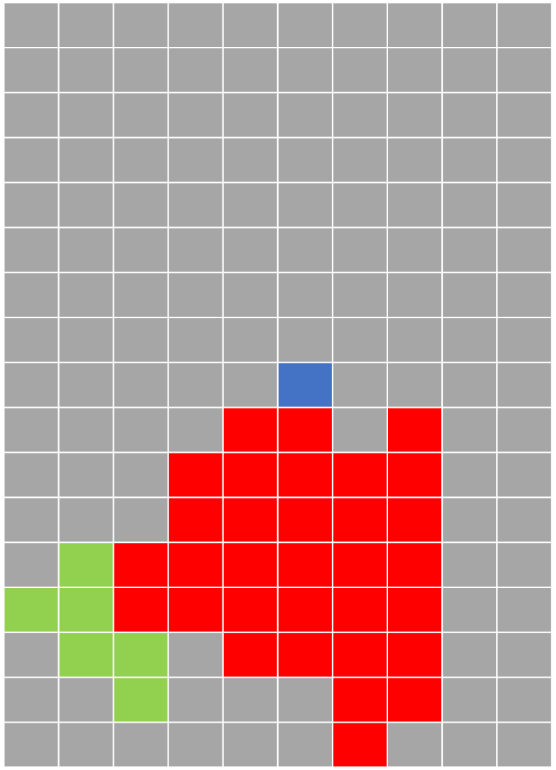


Fire prediction on 08/31/2022



Accuracy: 0.86

Fire prediction on 09/01/2022



Accuracy: 0.55

Observation of fire

True positive

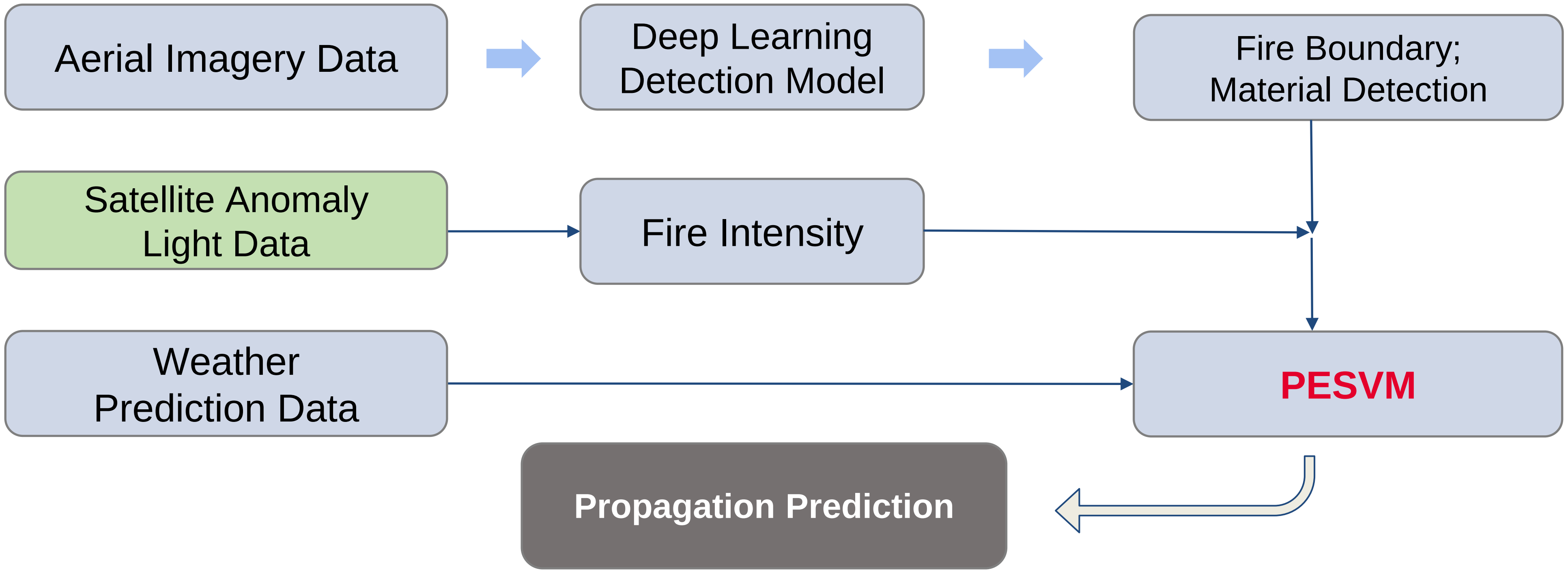
No fire

False positive

False negative
(Not shown for 09/01)

Contributions

A novel approach is proposed for Wildfire propagation prediction by fusion of imagery data and weather prediction data.



Wildfire Propagation Prediction Framework

QUESTIONS