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# **Beyond the Façade**: Using Façade-View Imagery and Deep Learning to Predict Likelihood of Demolition

Samuel Alter

Senior Analyst, Data Science

Reveal Global Consulting | GWF: Amsterdam ’26

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# Meet the Speaker

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# Meet the Speaker

Samuel
Alter

Senior Analyst, Data Science

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# Meet the Speaker

Samuel Alter

Senior Analyst, Data Science

Geospatial data scientist and trained geologist

- Prior career in environmental consulting

Reveal Global Consulting is a data consultancy specializing in federal, state, and local government contracts

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# Acknowledgements






Lei Peng
Senior Data Engineer

Michael Ratcliffe
Senior Advisor

Taylor J. Wilson
VP, Applied Statistics and Data Science

Angi Lee
Director, Reveal Labs

Hector Ferronato
VP, Engineering


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# Context

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- Remote methods

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# Goal

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# Goal: Two-Stage Model

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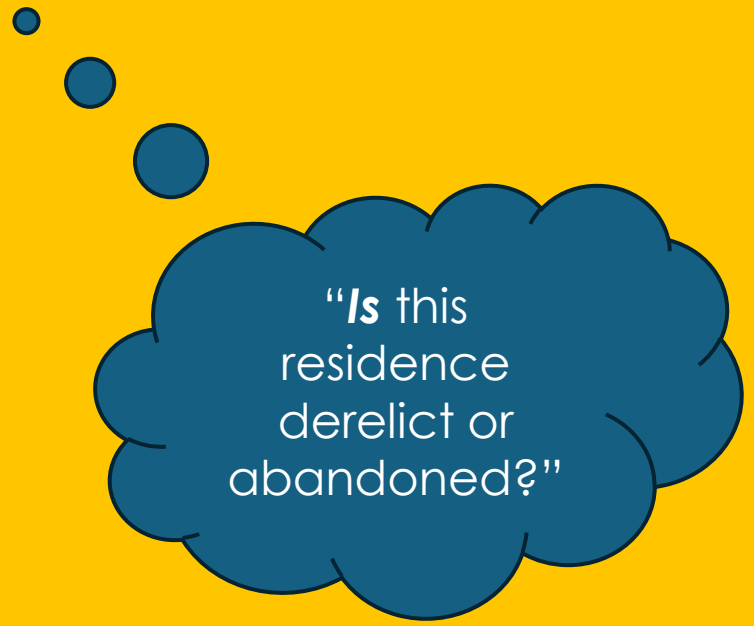
Stage 1: Dereliction detection model

# Goal: Two-Stage Model

## Stage 1: Dereliction detection model

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# Goal: Two-Stage Model

Stage 1: Dereliction detection model

Stage 2: Demolition prediction model

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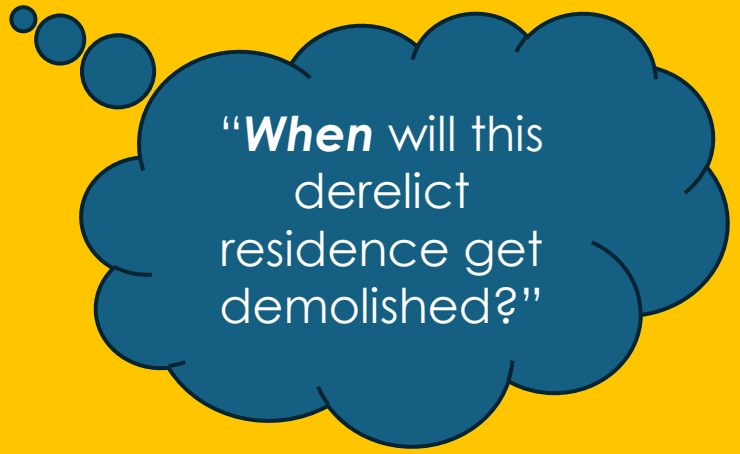
Stage 1: Dereliction detection model

Stage 2: Demolition prediction model

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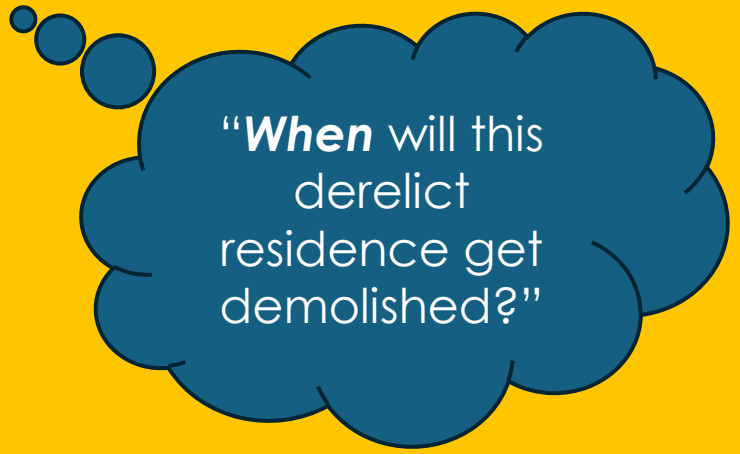
# Goal: Two-Stage Model

Stage 1: Dereliction detection model

**Stage 2: Demolition prediction model**

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# Goal

Develop an approach that automates the pre-survey procedure, specifically whether a residence should be removed from an address list due to demolition within a time horizon

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Be as frictionless as possible:

- Bulk or single address input
- Display retrieved façade imagery

# Goal

Develop an approach that automates the pre-survey procedure, specifically whether a residence should be removed from an address list due to demolition within a time horizon

Be as frictionless as possible:

- Bulk or single address input
- Display retrieved façade imagery
- Output demolition prediction

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# 4

# METHODOLOGY

# Methodology – Overview

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1. Acquire data of demolished homes

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3. Train model to draw masks on façades in imagery

# Methodology – Overview

1. Acquire data of demolished homes
2. Acquire façade imagery
3. Train model to draw masks on façades in imagery
4. Train demolition model to predict likelihood of demolition within 48 months

# Methodology – 1. Demolition Data

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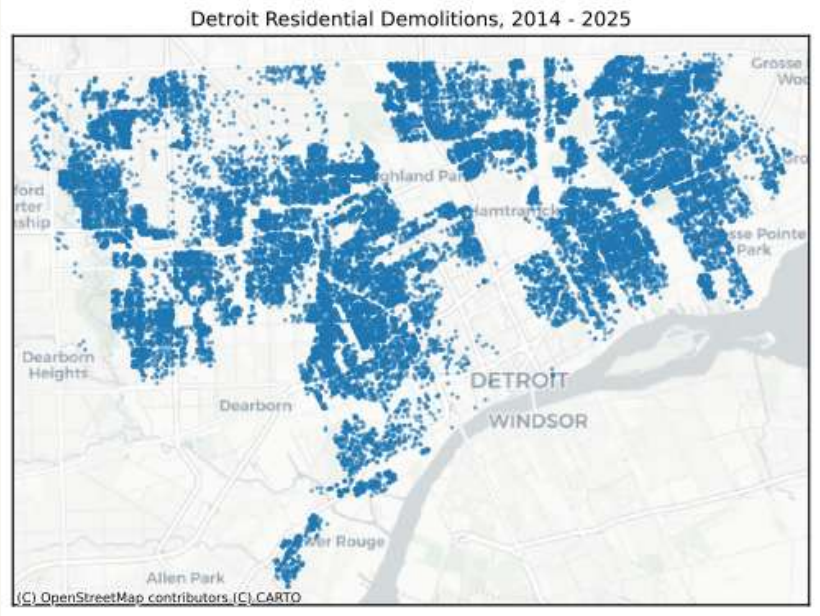


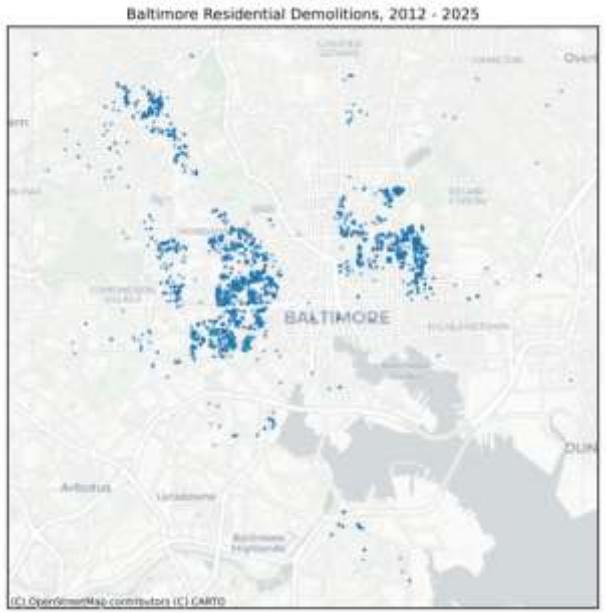


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# Methodology – 1. Demolition Data

Detroit

Baltimore

**Data for *residential homes* includes *location* and *demolition date***

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# Methodology – 2. Façades



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# Methodology – 2. Façades

Image retrieval pipeline



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# Methodology – 2. Façades

Image retrieval pipeline

- Google Street View API



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# Methodology – 2. Façades

Image retrieval pipeline

- Google Street View API
- OpenStreetMap



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# Methodology – 2. Façades

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- Google Street View API
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- Municipal parcel data



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# Methodology – 2. Façades

Image retrieval pipeline

- Google Street View API
- OpenStreetMap
- Municipal parcel data

User Interface



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# Methodology – 3. Masking



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# Methodology – 3. Masking

Frozen SAM2 image encoder

Meta SAM 2



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# Methodology – 3. Masking

Frozen SAM2 image encoder

- Trained lightweight 3-class head on gold labeled masks

Meta SAM 2



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# Methodology – 4. Model



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# Methodology – 4. Model

Data exclusively of demolished homes



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# Methodology – 4. Model

Data exclusively of demolished homes

Training data usage: **29,052** total images

- Train images: **24,289**
- Val images: **2,323**
- Test images: **2,440**



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# Methodology – 4. Model

Data exclusively of demolished homes

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Base rate at ≤ 48 months: **28.7%**



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Data exclusively of demolished homes

Training data usage: **29,052** total images

- Train images: **24,289**
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- Test images: **2,440**

Base rate at ≤ 48 months: **28.7%**

Trained on gold, silver, and bronze-tier masked façade imagery



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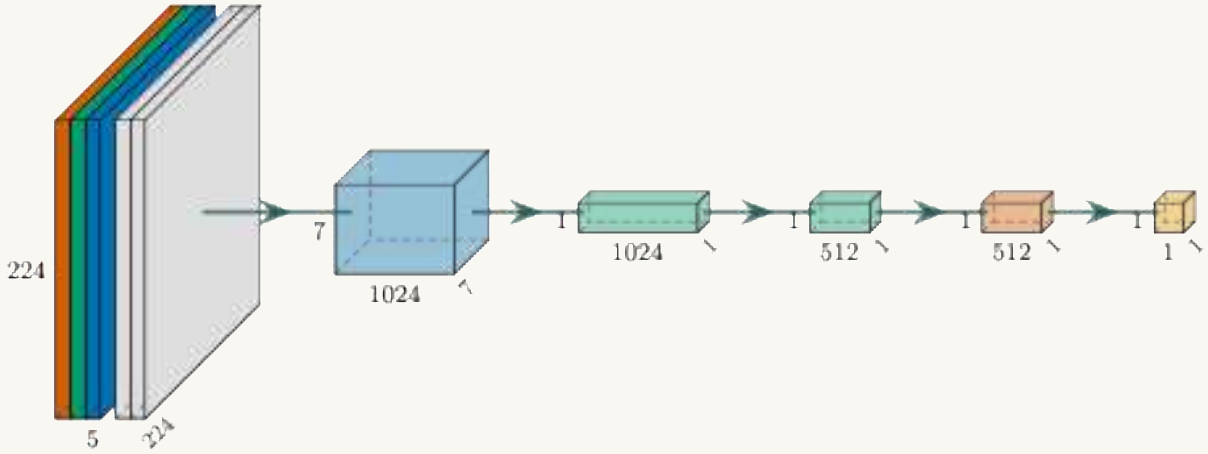
# Methodology – 4. ConvNeXt Model



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# Façade Model and User Interface

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# Façade Model

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Goal: Predict likelihood of demolition **within 48 months (1460 days)**

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Find a prediction threshold that maximizes recall with precision ≥ 0.80: **0.7891**

# Façade Model – Confusion Matrix Examples

Goal: Predict likelihood of demolition **within 48 months (1460 days)**

Find a prediction threshold that maximizes recall with precision ≥ 0.80: **0.7891**

# True Positive

## Predicted demo ≤ 48 months

Address ID = 6196036

- Captures from **2009** to **2022**
- Demo date: **2024-08-20**
- Days to demolition (from last): **719**
- Model score: **0.945** (>0.7891)


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# True Positive

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- Model score: **0.945** (>0.7891)
- Post-demo photo: **2025-03-01**

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# False Positive

## Predicted demo ≤ 48 months

Address ID = 6828690

- Captures from **2009** to **2013**
- Demo date: **2018-05-10**
- Days to demolition (from last): **1743**
- Model score: **0.898** (>0.7891)


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# False Positive

## Predicted demo ≤ 48 months

Address ID = 6828690

- Captures from **2009** to **2013**
- Demo date: **2018-05-10**
- Days to demolition (from last): **1743**
- Model score: **0.898** (>0.7891)
- Post-demo photo: **2018-07-01**

# Façade Model Performance

| Metrics<br>Threshold = 0.7891, n=2440 | |
|---|---|
| Accuracy | 85.7% (Base rate = 28.7%) |
| Precision | 82.1% |
| Recall | 64.1% |
| F1 | 0.72 |

| | Predicted | | PR-AUC | 0.83 |
|---|---|---|---|---|
| Actual | Positive | Negative | AUROC | 0.95 |
| Positive | TP: 449<br>(18.4%) | FN: 251<br>(10.3%) | Brier<br>(replay aggregate) | 0.1 |
| Negative | FP: 98<br>(4.0%) | TN: 1642<br>(67.3%) | ECE<br>(replay aggregate) | 0.07 |

# User Interface

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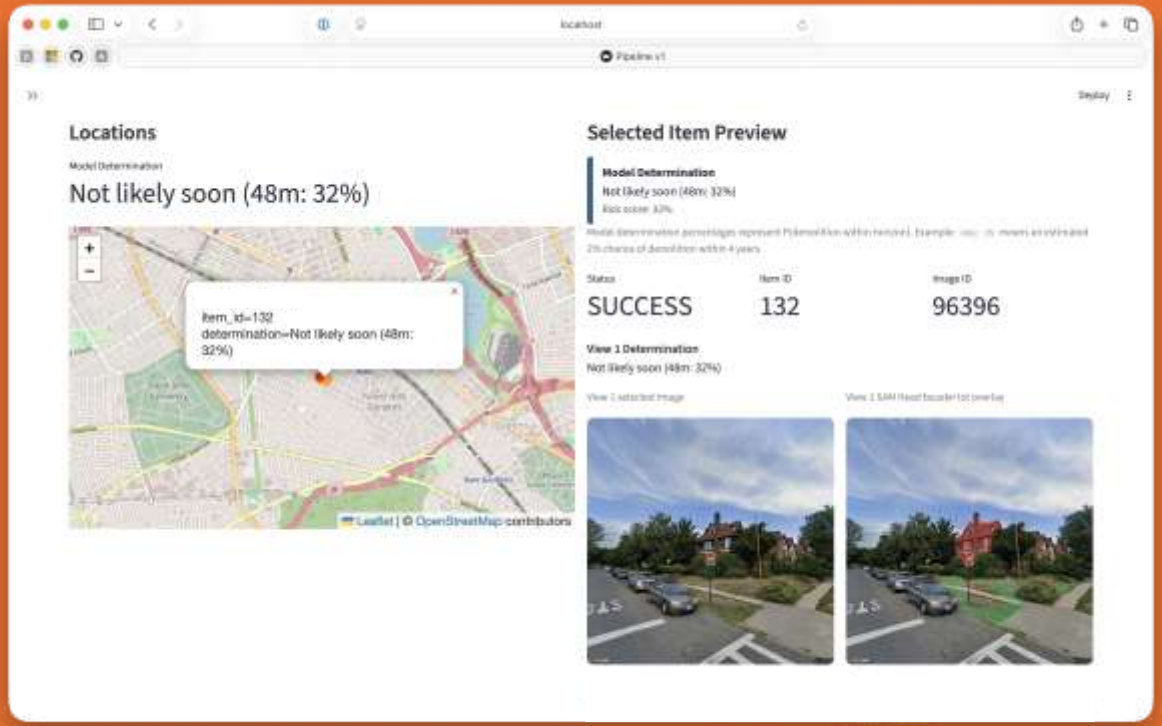

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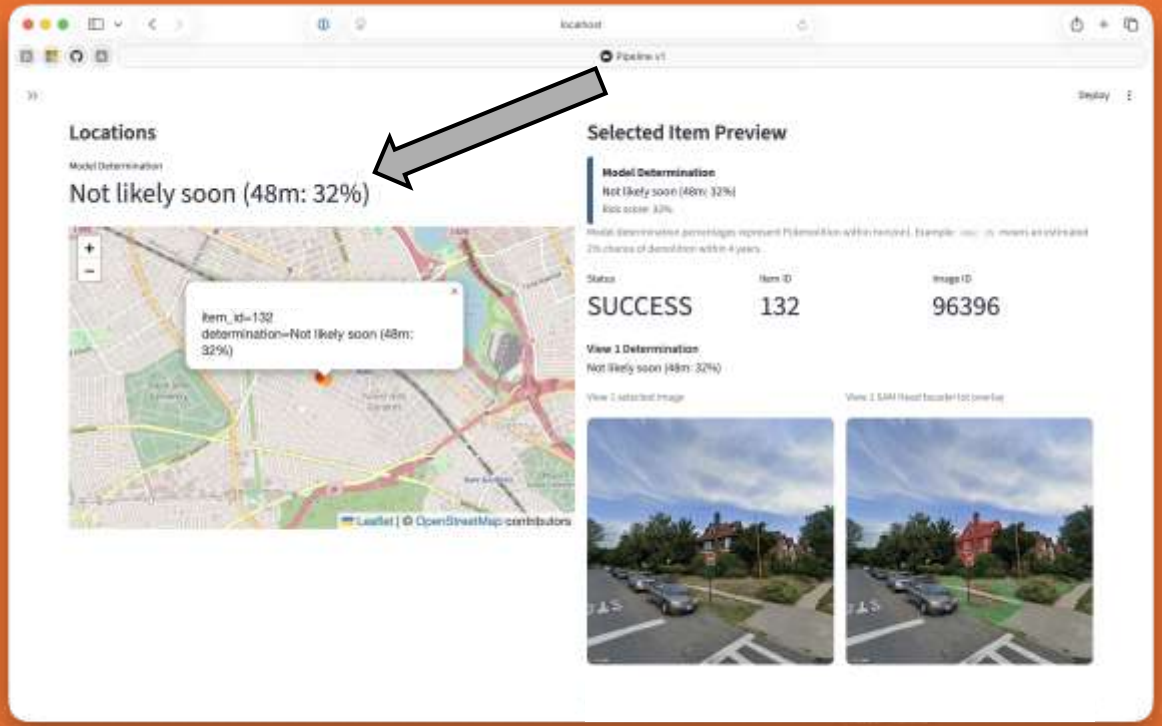

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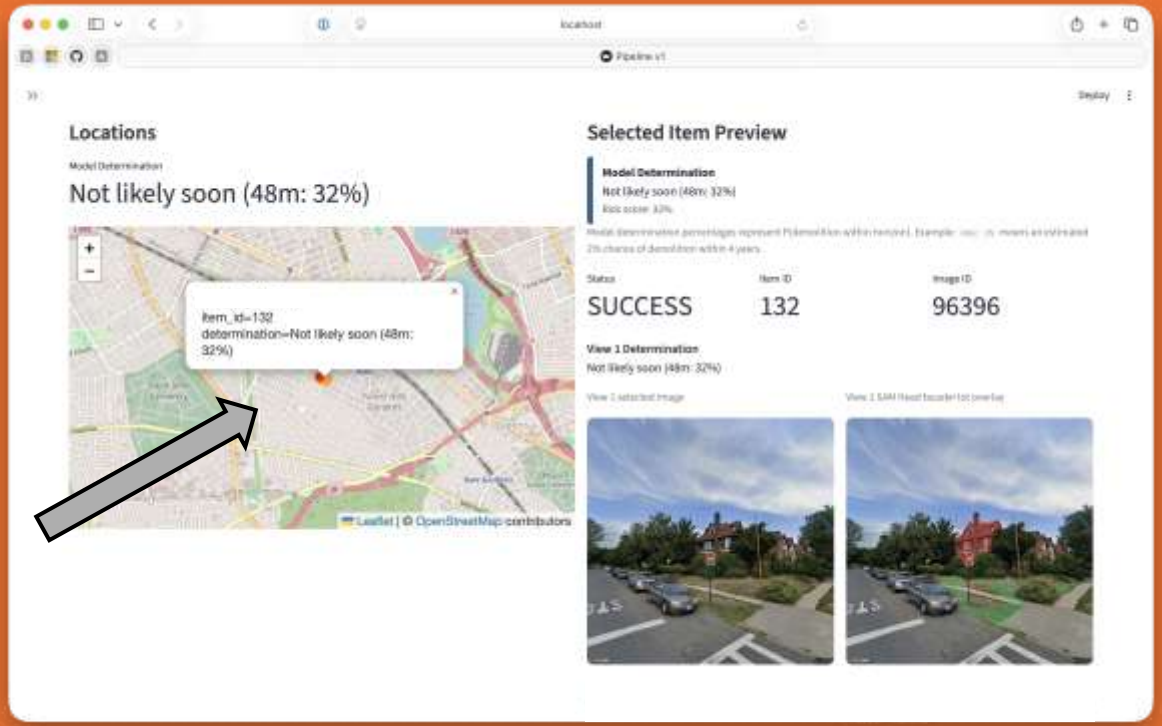

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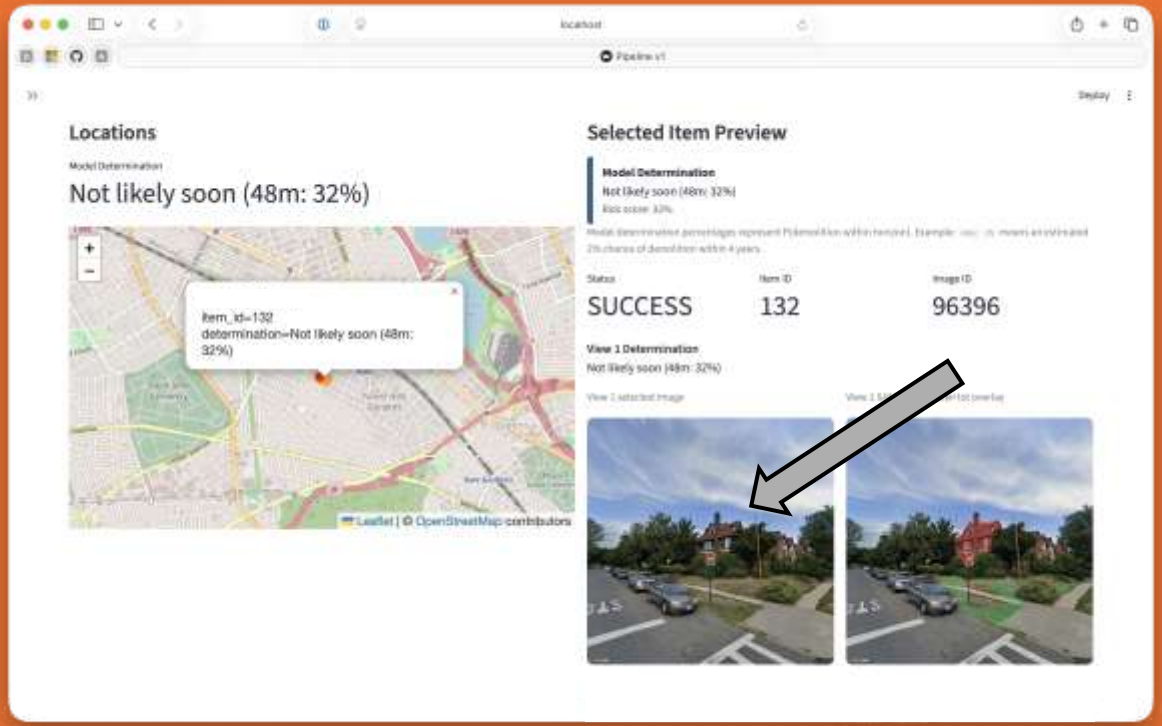

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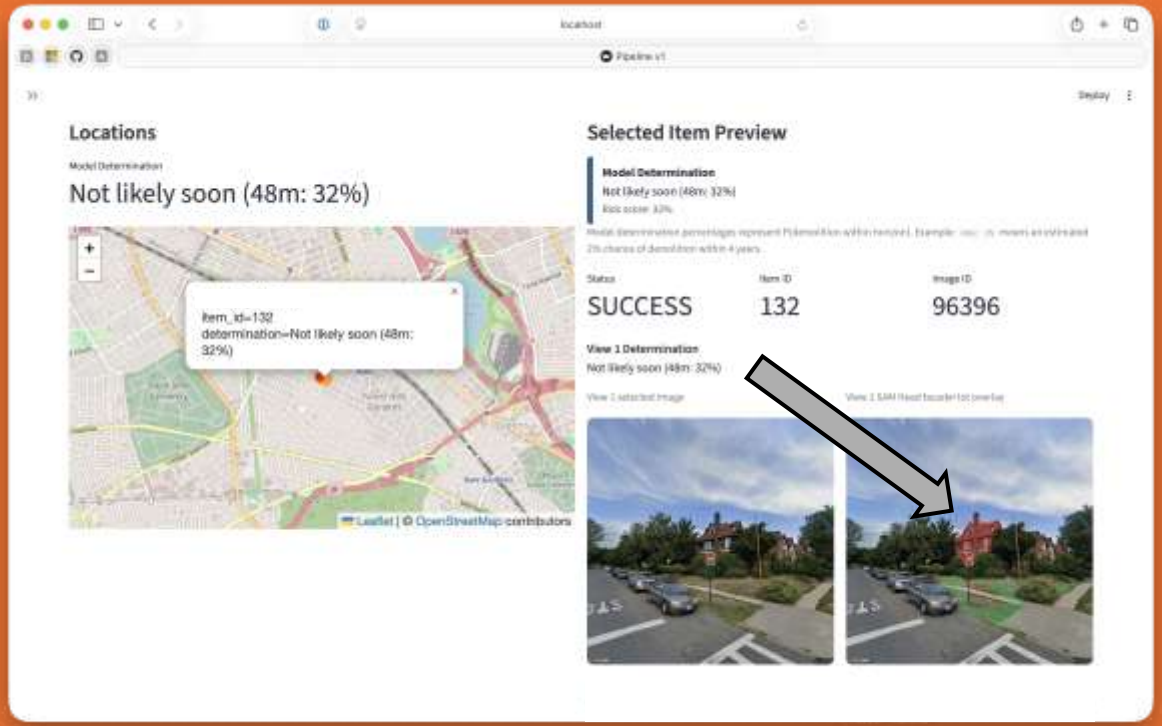

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# 6

# Project goal revisited, considerations, and future steps

# Goal Revisited: Stage 2

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Aim: Demonstrate an approach that outputs demolition risk of residential homes using façade imagery for survey address review

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✓ Acquire façade imagery of residential demolitions

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Train model on image + mask data to learn demolition patterns in imagery

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# Goal Revisited: Stage 2

Aim: Demonstrate an approach that outputs demolition risk of residential homes using façade imagery for survey address review

- ✓ Acquire façade imagery of residential demolitions
- ✓ Mask images to identify address in image
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# Considerations

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- Privacy

# Considerations

Privacy

Imagery sourcing, licensing, and limitations

# Model: Where do we go from here?

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Expand predictions to more cities and shorter timescales:

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- 24-month

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More prediction outputs:

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More prediction outputs:

- Residential vs. Commercial

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- Number of dwelling units

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More prediction outputs:

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- Number of dwelling units
- Building feature analysis

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- How many people live in a dwelling unit
- Residential blight rate
- Neighborhood health
- Housing trends

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- Neighborhood health
- Housing trends
- …!

# Thank You

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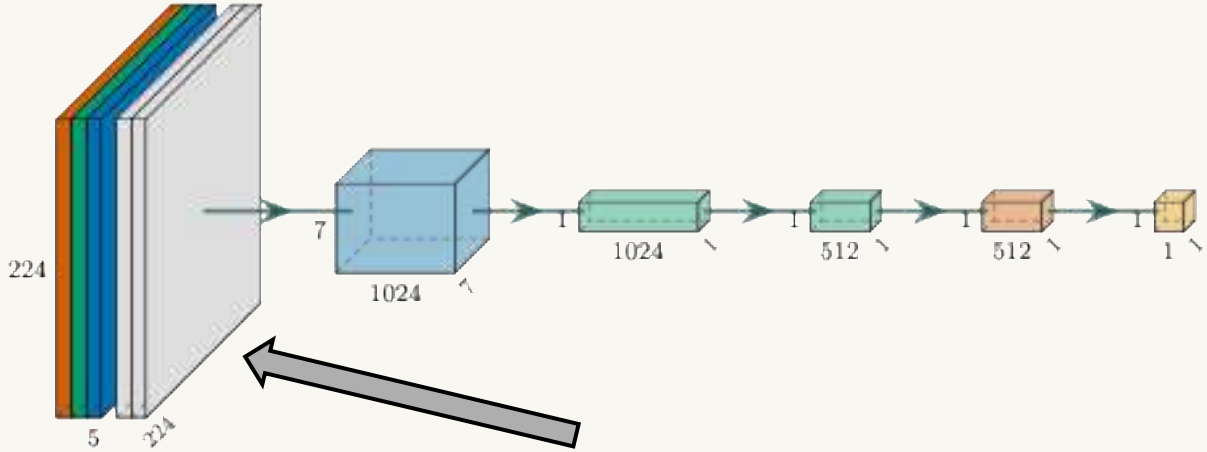
hector.ferronato@revealgc.com

# Methodology – 4. ConvNeXt Model




**Input 5-channel sequence of images**:
3-channel image (RGB) and 2-channel mask (Façade + Lot)
4x5x224x224

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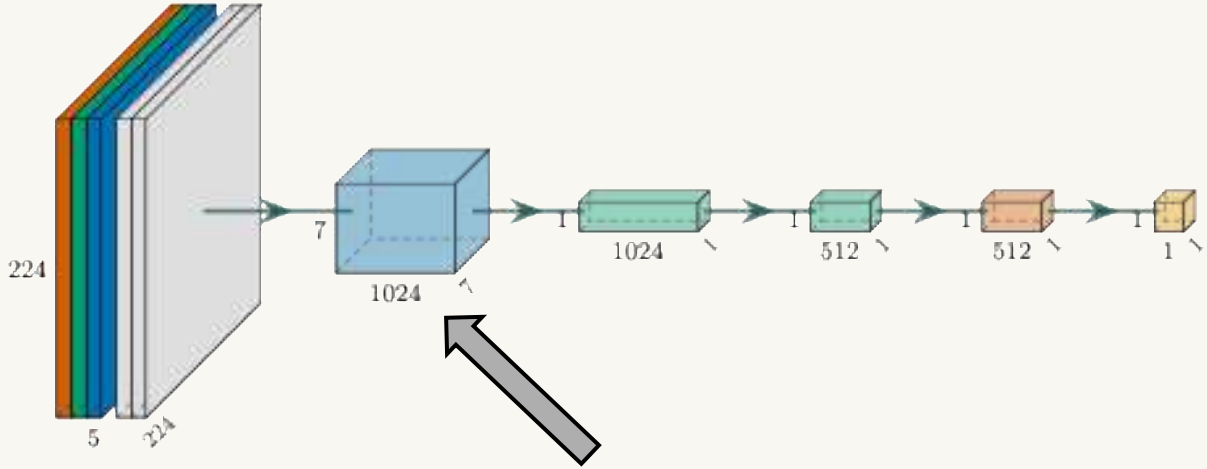
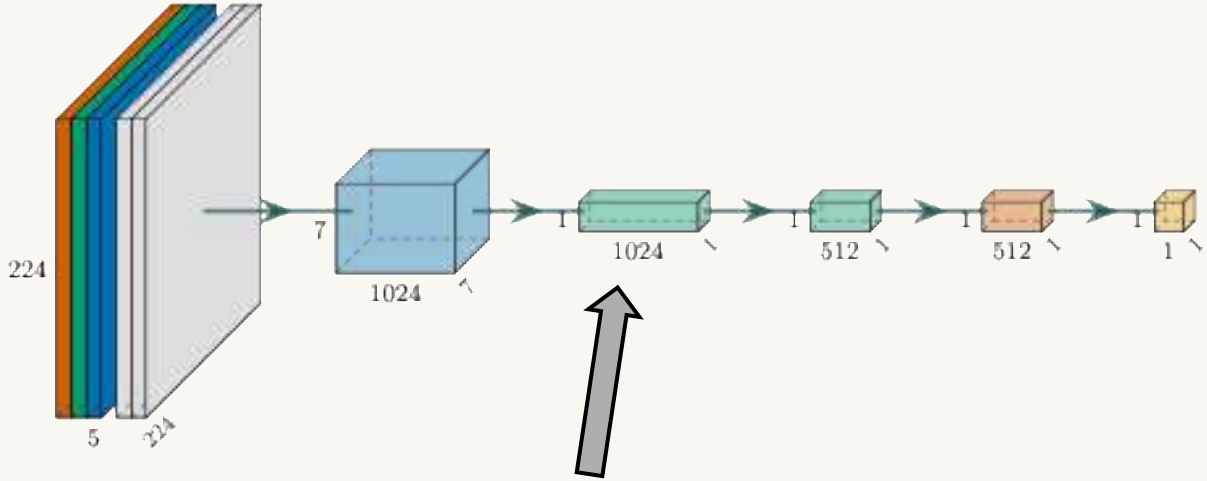
# Methodology – 4. ConvNeXt Model



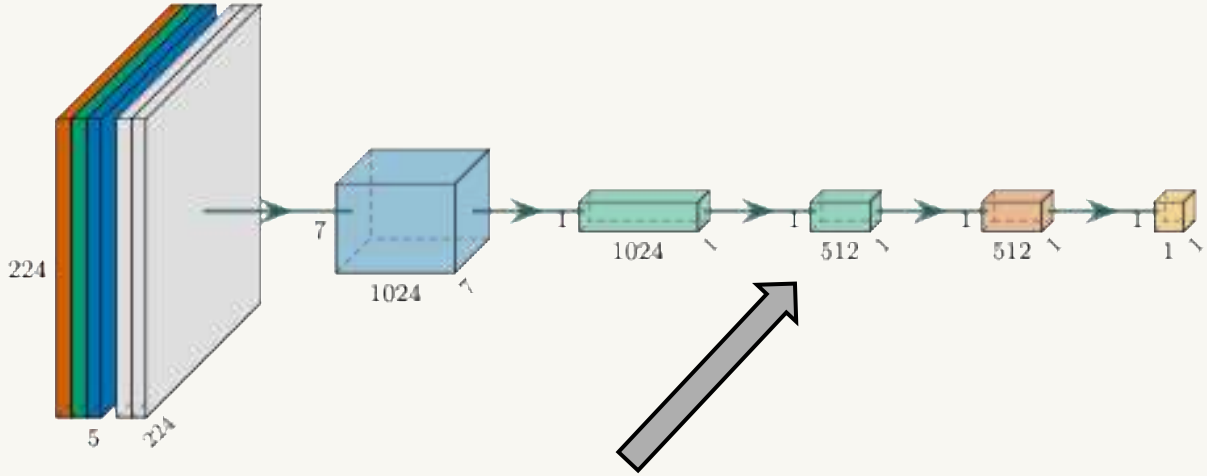

**4-stage ConvNeXt Spatial Encoder**:
Extract abstract features while downsampling resolution
4x224x224x5 →→ 4x7x7x1024

# Methodology – 4. ConvNeXt Model




**Global Average Pooling**:
Summarizes each image into a single vector
4x7x7x1024 → 4x1x1x1024

# Methodology – 4. ConvNeXt Model

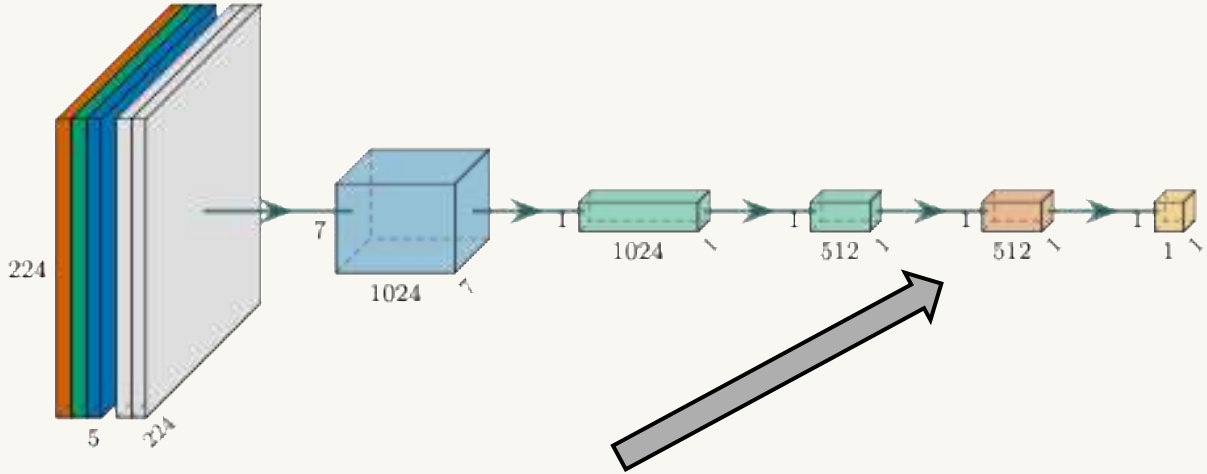



**Temporal Metadata**:

days_since_first

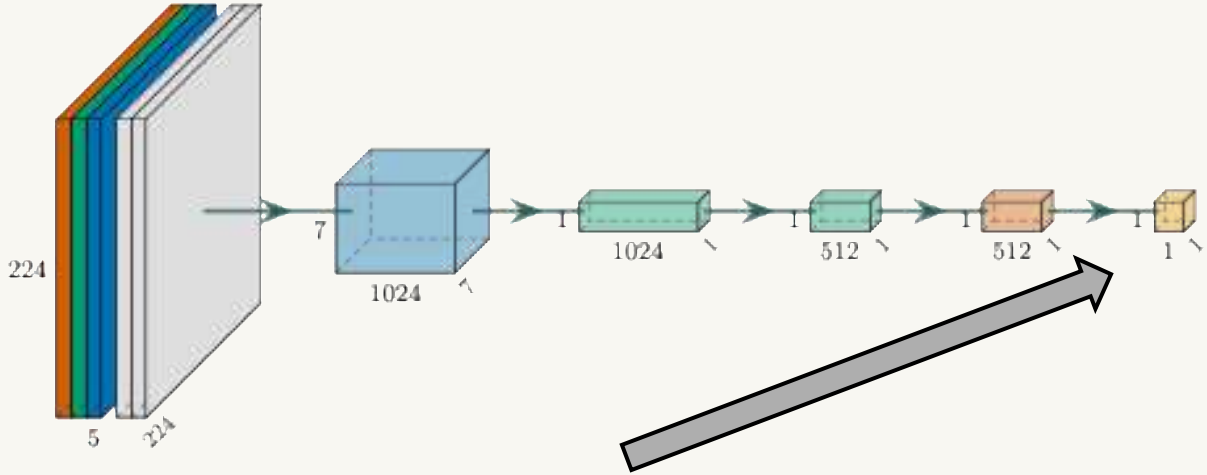
4x1x1x1024 → 4x1x1x512

# Methodology – 4. ConvNeXt Model




**Transformer**:
Uses self-attention to identify temporal trends
4x1x1x512

# Methodology – 4. ConvNeXt Model




**Hazard Head (48-month demolition risk)**:
Converts summarized temporal features into single probability
4x1x1x512 → 1x1x1x1

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# SAM Head Performance

| Overall Metrics | |
|---|---|
| test_mean_iou | 0.6973 |
| test_iou_facade | 0.6863 |
| test_iou_lot | 0.4979 |
| n_test_samples | 102 |

| Metrics – Façade | | Metrics – Lot | |
|---|---|---|---|
| Precision | 82.15% | Precision | 61.51% |
| Recall | 78.75% | Recall | 84.83% |
| F1 | 80.42% | F1 | 71.31% |

# SAM Head Performance – High IoU

Example Address (same as right image)

Example Address (same as left image)

Reveal Labs

# SAM Head Performance – High IoU

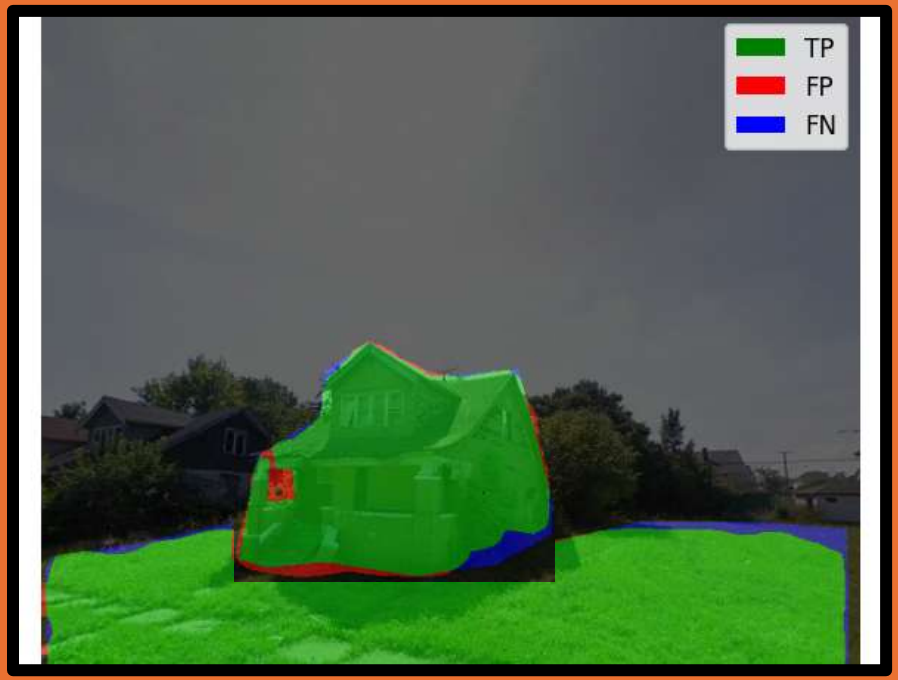

Ground Truth (i.e., Human-labeled)


**SAM Head Output (i.e., Machine-labeled)**

Reveal Labs

# SAM Head Performance – High IoU


Ground Truth (i.e., Human-labeled)




**SAM Head Output (i.e., Machine-labeled)**

# SAM Head Performance – Low IoU

Example Address (same as right image)

Example Address (same as left image)

Reveal Labs

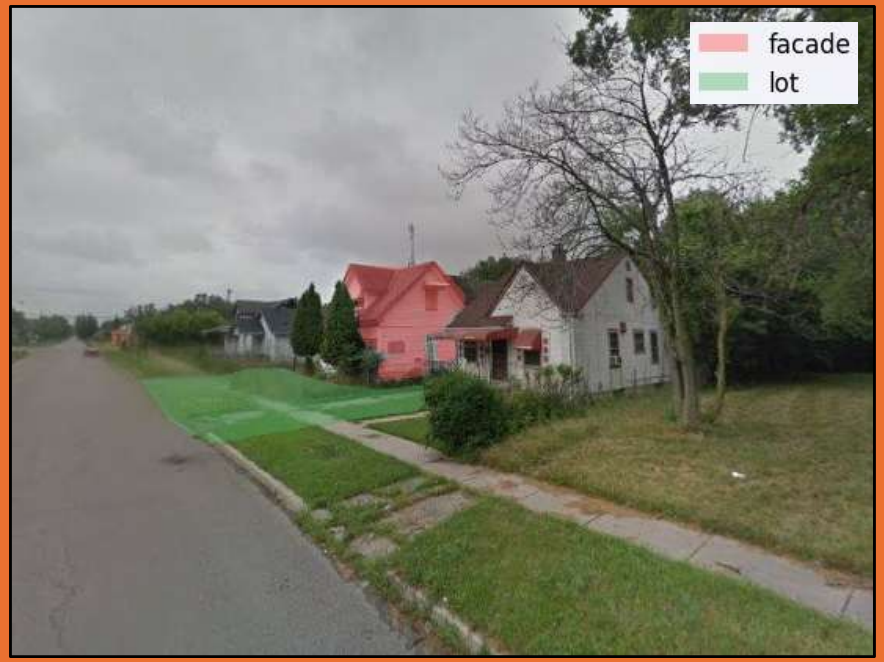
# SAM Head Performance – Low IoU

Ground Truth (i.e., Human-labeled)

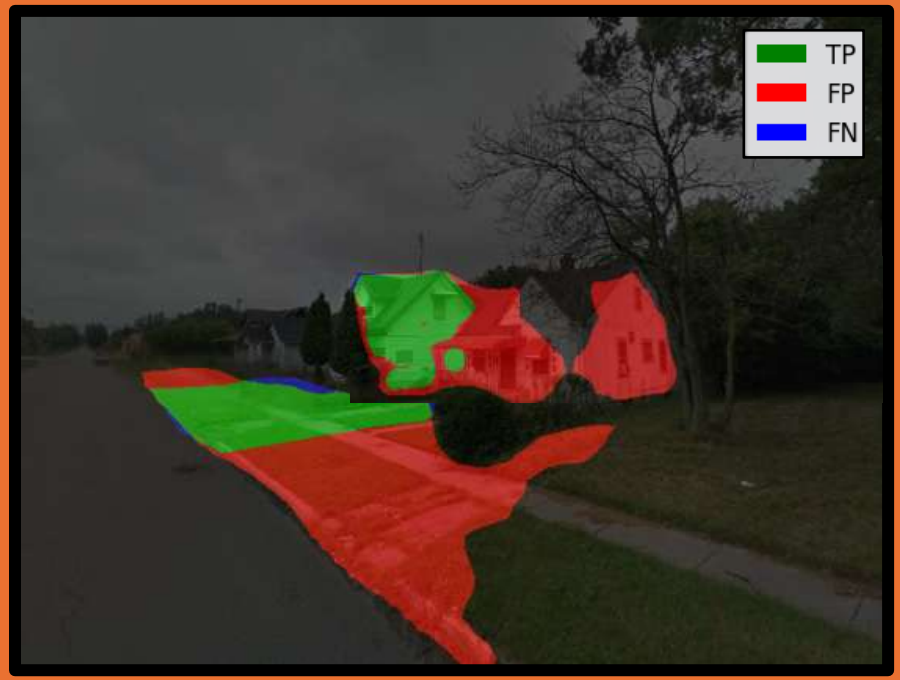
**SAM Head Output (i.e., Machine-labeled)**

Reveal Labs

# SAM Head Performance – Low IoU




Ground Truth (i.e., Human-labeled)




**SAM Head Output (i.e., Machine-labeled)**

Façade and Lot Mask Comparison with Ground-Truth

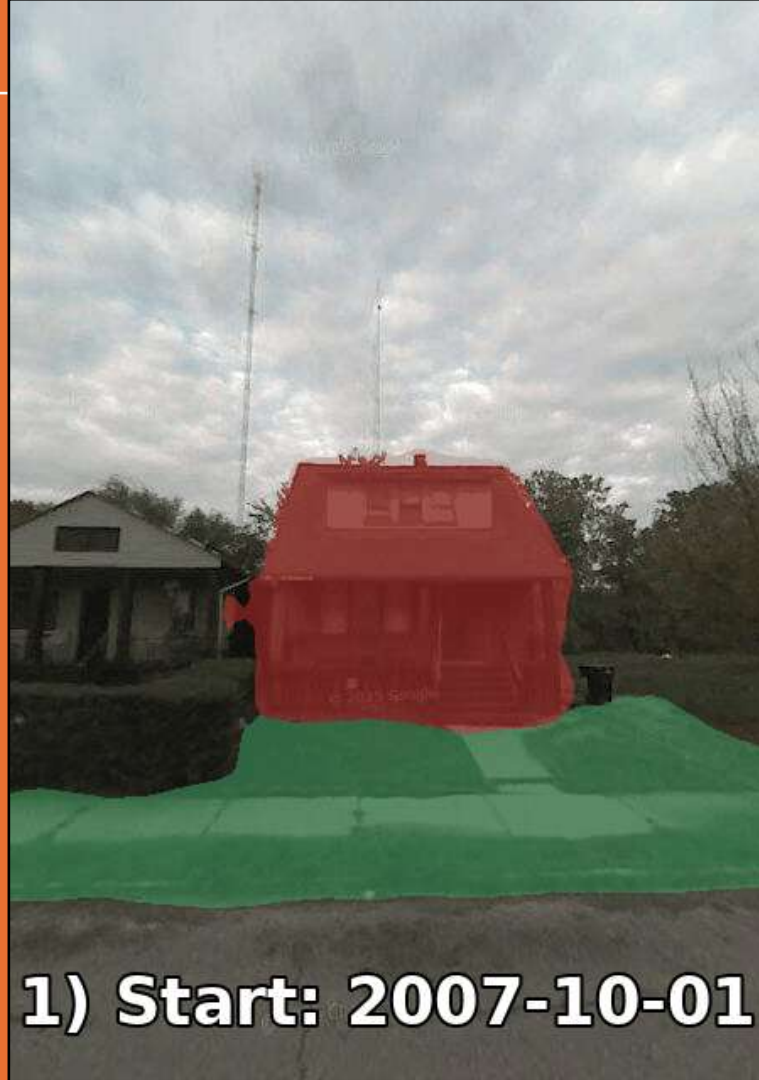
Reveal Labs

# True Negative

## Predicted demo > 48 months

Address ID = 6033633

- Captures from **2007** to **2019**
- Demo date: **2024-02-20**
- Days to demolition (from last): **1725**
- Model score: **0.597** (<0.7891)



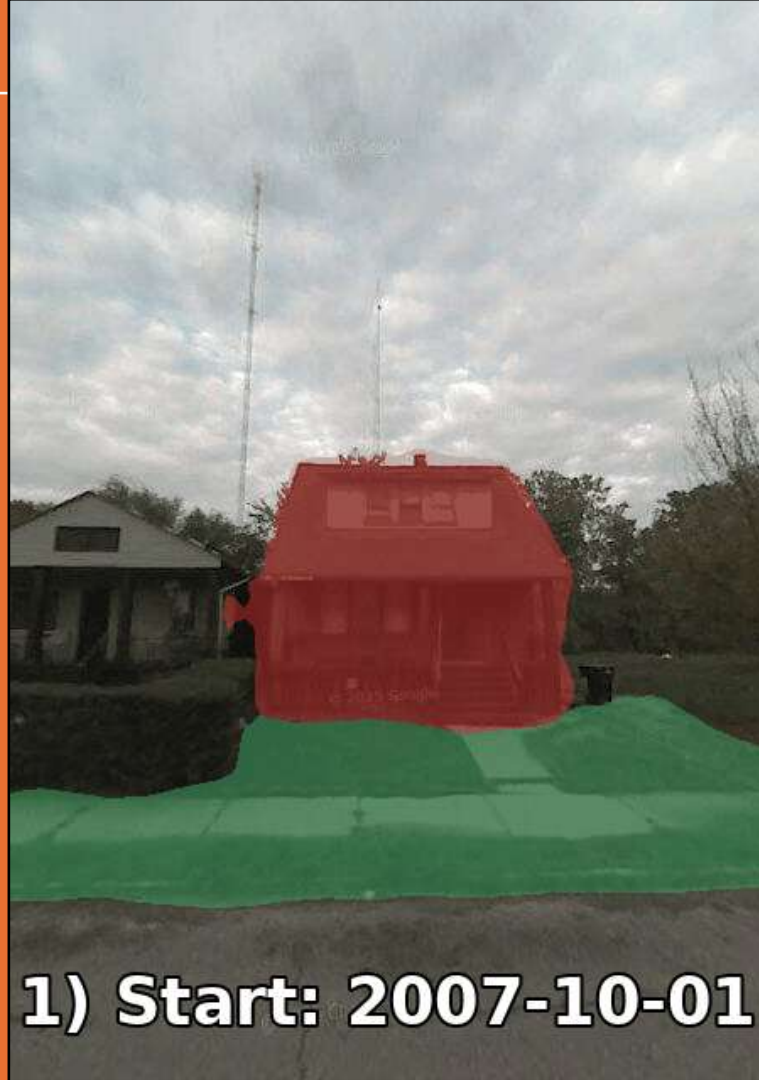

Reveal Labs

# True Negative

## Predicted demo > 48 months

Address ID = 6033633

- Captures from **2007** to **2019**
- Demo date: **2024-02-20**
- Days to demolition (from last): **1725**
- Model score: **0.597** (<0.7891)
- Post-demo photo unavailable



# False Negative

## Predicted demo > 48 months

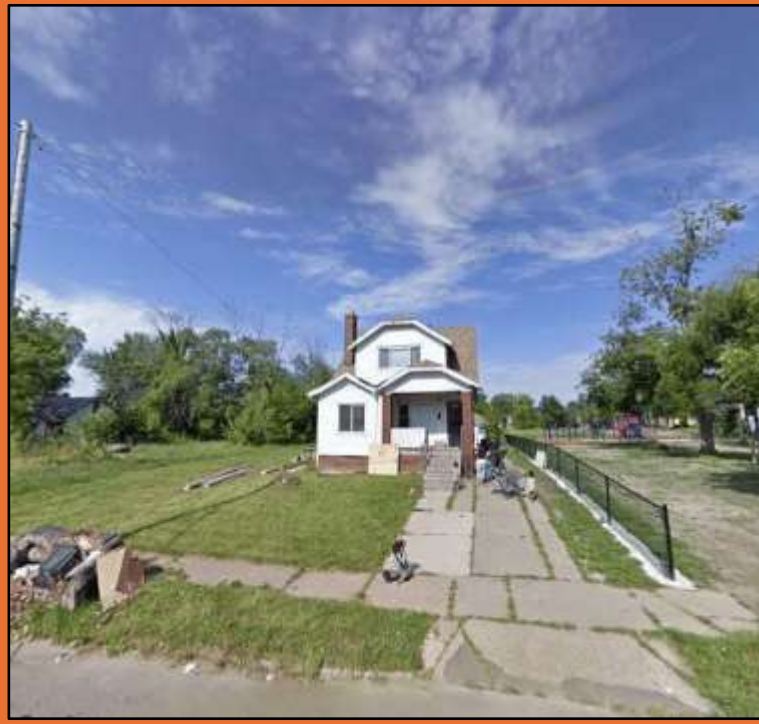
Address ID = 6022716

- Captures from **2009** to **2019**
- Demo date: **2019-08-16**
- Days to demolition (from last): **46**
- Model score: **0.572** (<0.7891)


Reveal Labs

# False Negative

## Predicted demo > 48 months



Address ID = 6022716

- Captures from **2009** to **2019**
- Demo date: **2019-08-16**
- Days to demolition (from last): **46**
- Model score: **0.572** (<0.7891)
- Post-demo photo: **2022-07-01**