

Detecting Road Surface Anomalies using Multimodal Machine Learning

Thesis Defense
Msc. Data Science and Entrepreneurship
Joël Luijmes, 14 Jan 2022

What is the problem

Road maintenance is ...



Annual costs of
2.5B - 3.5B EUR



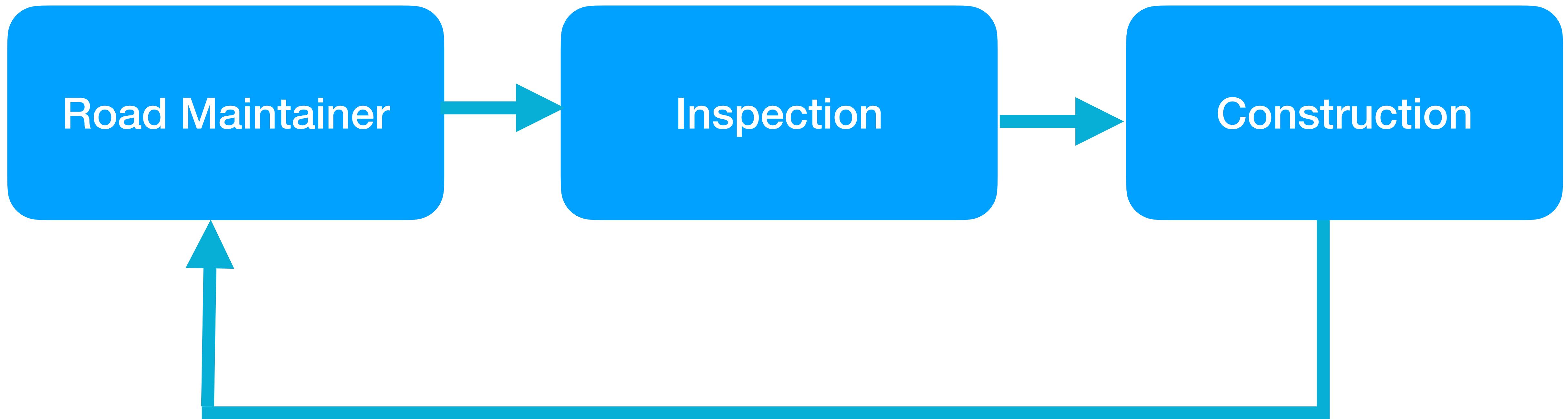
Slow and labor
intensive process



Relies largely on
expert knowledge

What is the problem

Current process is slow

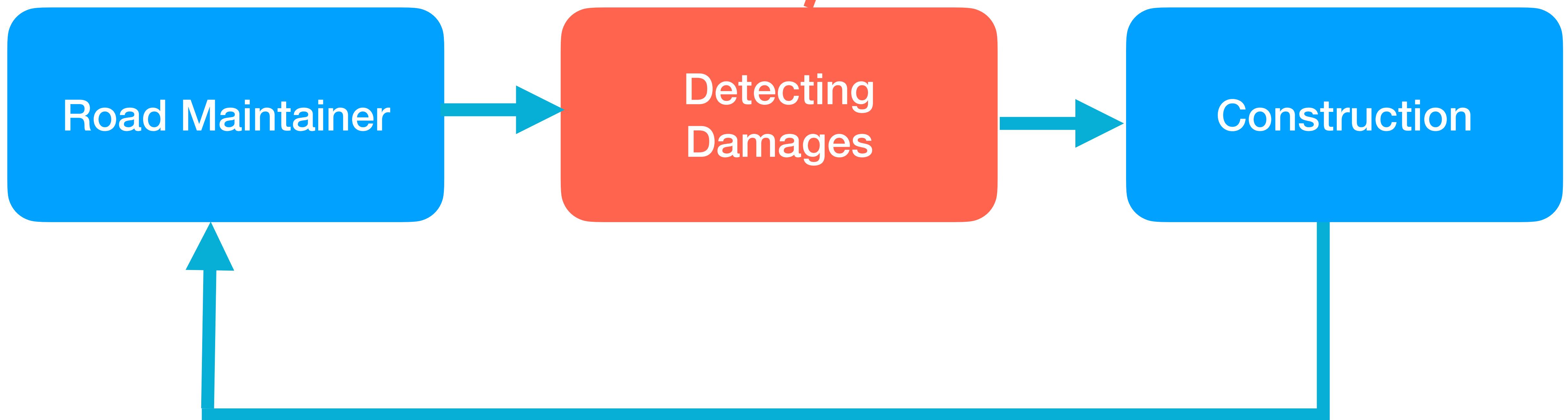


Solution

Make it data driven

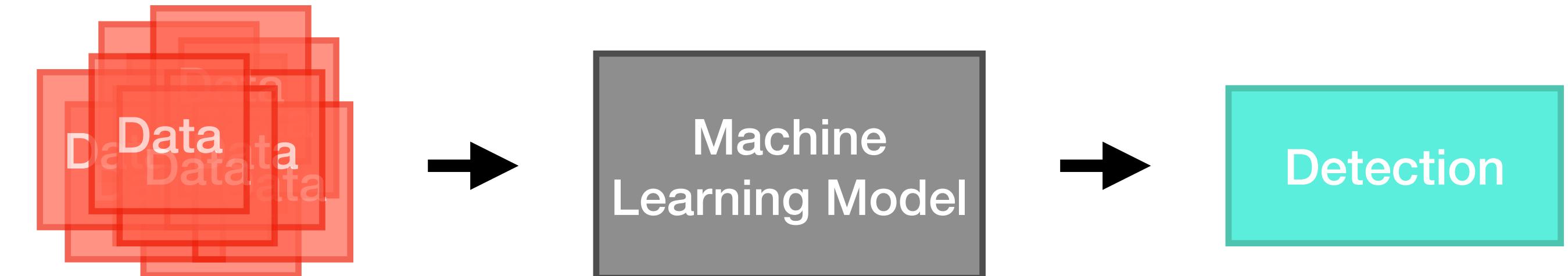
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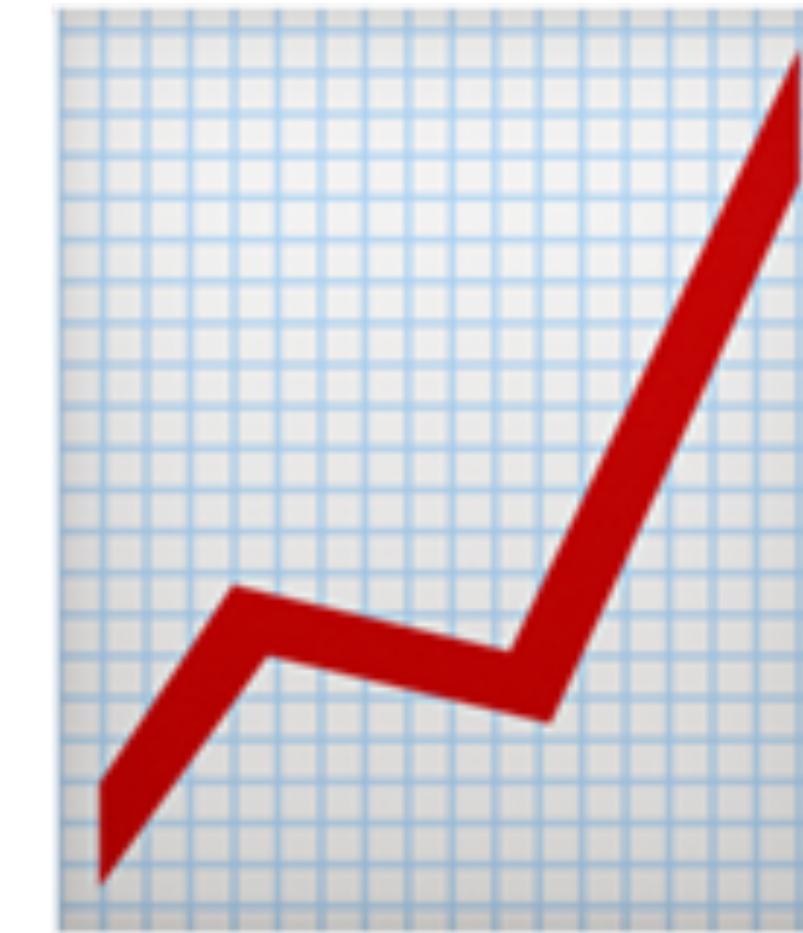


What is currently known

Machine Learning classification in a nutshell



Visual Surface Defects Detection
using Machine Learning



Sensor Defects Detection
using Machine Learning

What is *not* known

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Visual Data



Accelerometer Data

Why do it



Novel research



Entrepreneurial



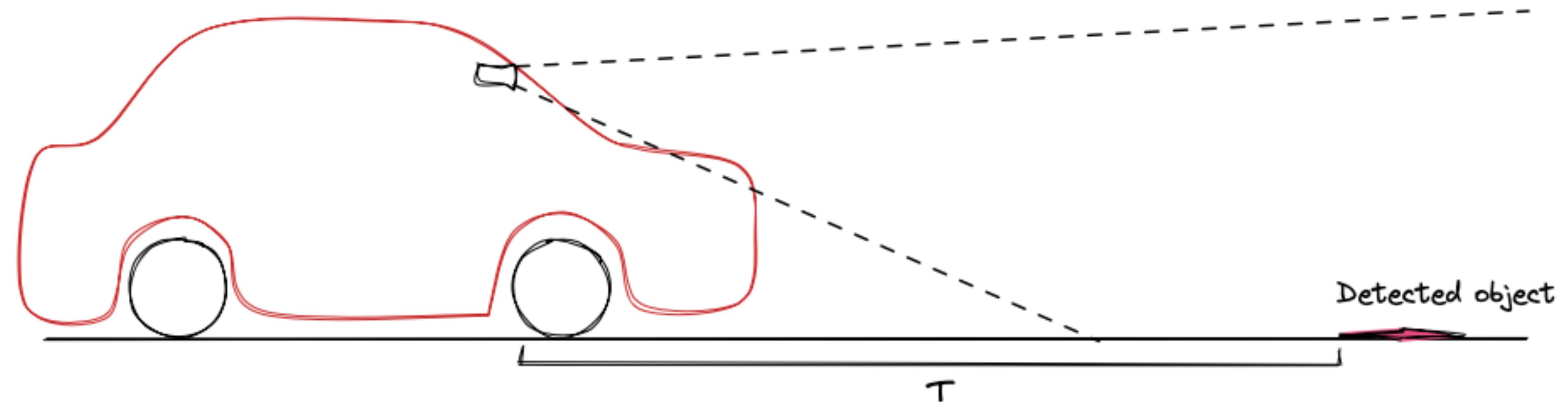
Visual + Accelerometer
are complementary

Why are both sources complementary



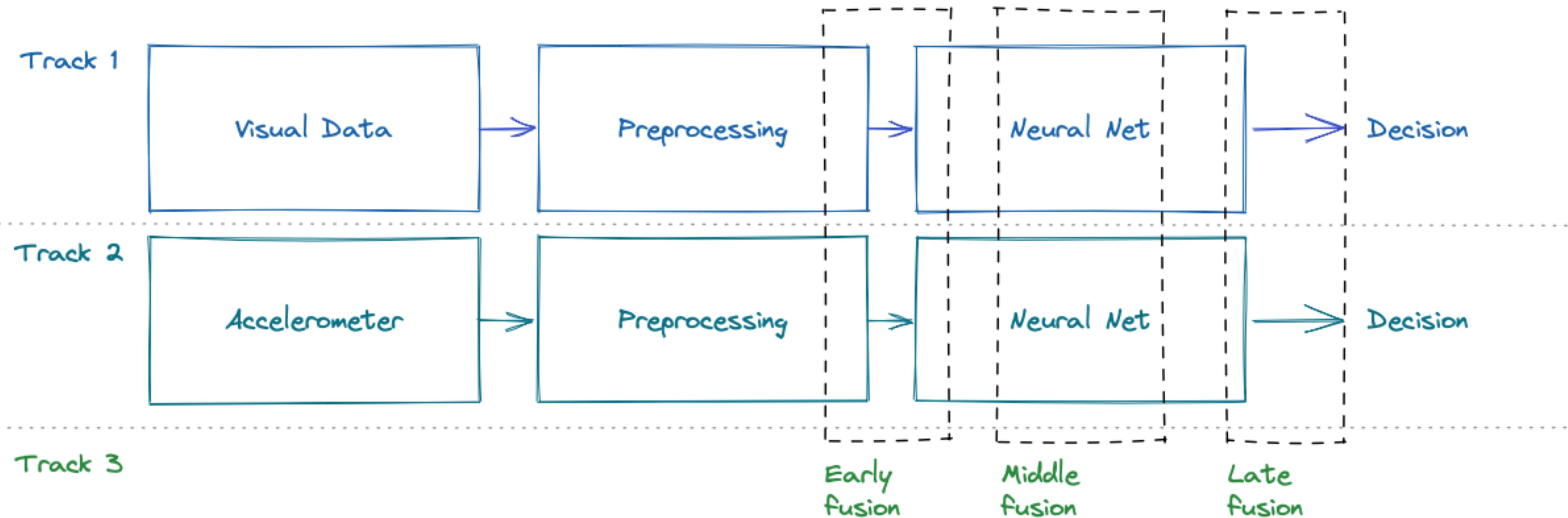
Experiment Setup

1. Data Collection
2. Data Analysis
3. Machine Learning Models
4. Evaluate Results



Experiment Setup

Overview of tracks



Data Collection



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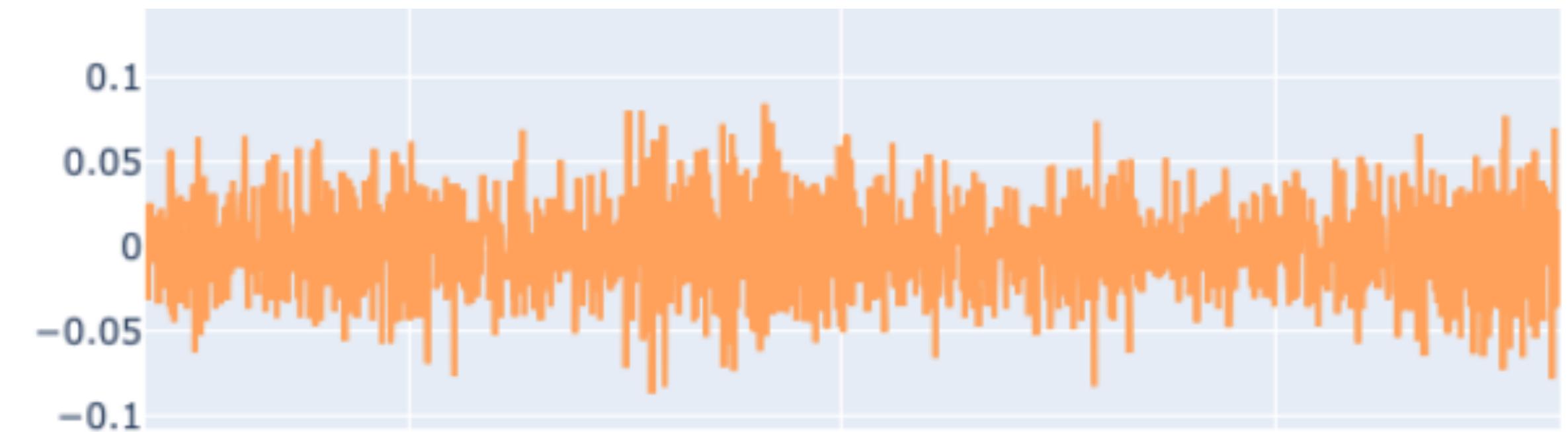
Data Analysis

Visual

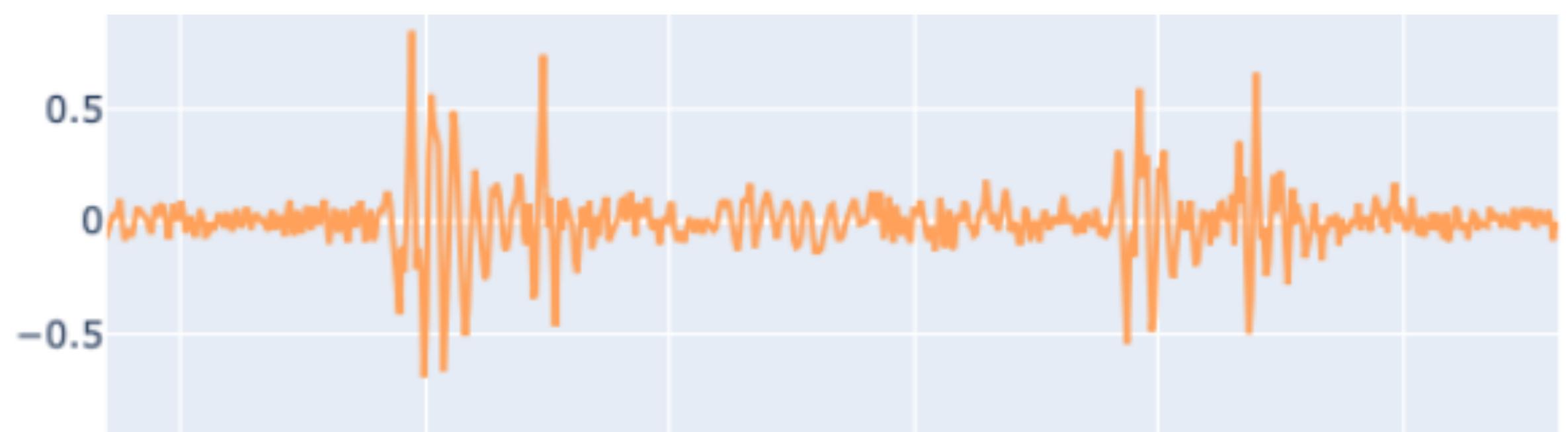


Accelerometer

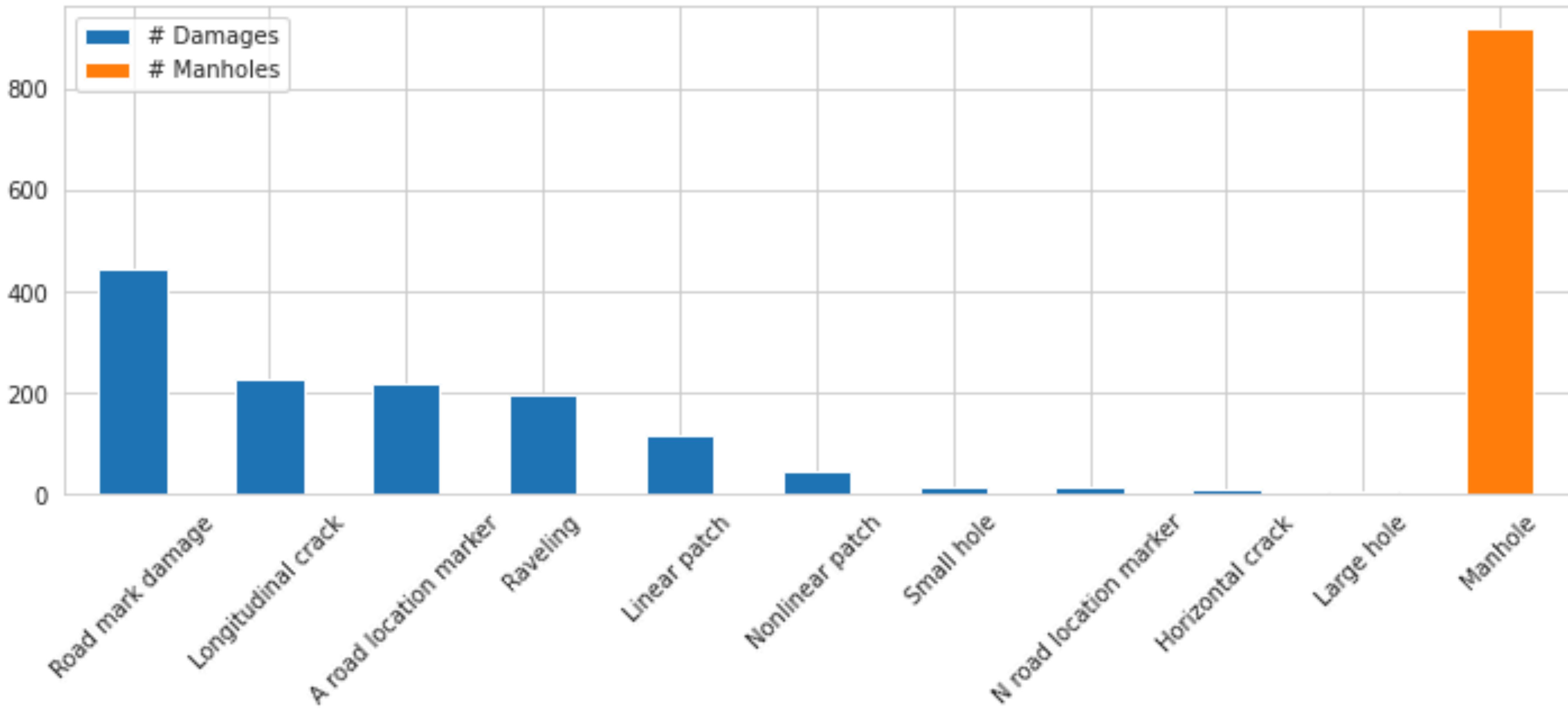
Normal signal



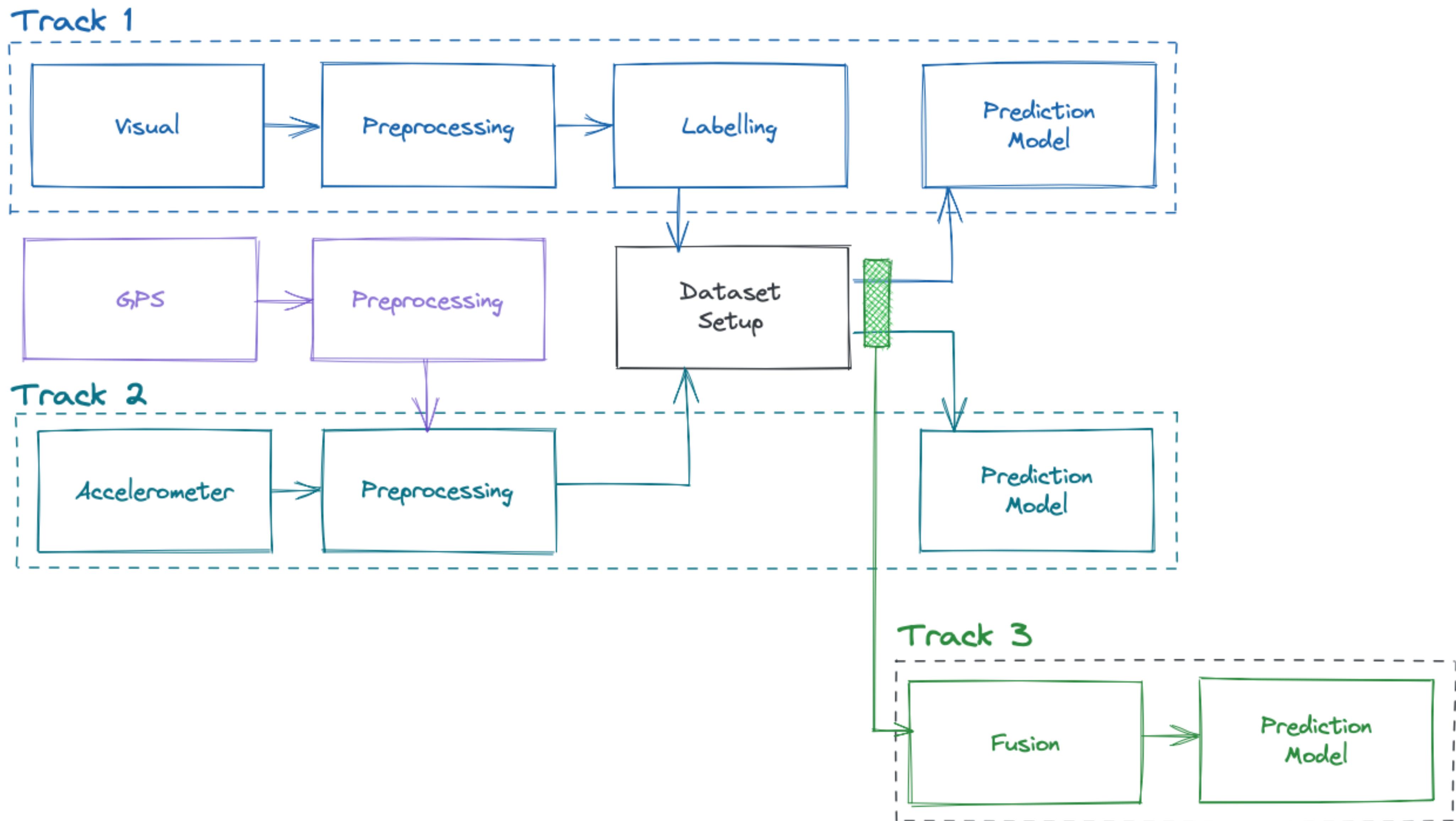
Driving over Anomaly



Data Analysis

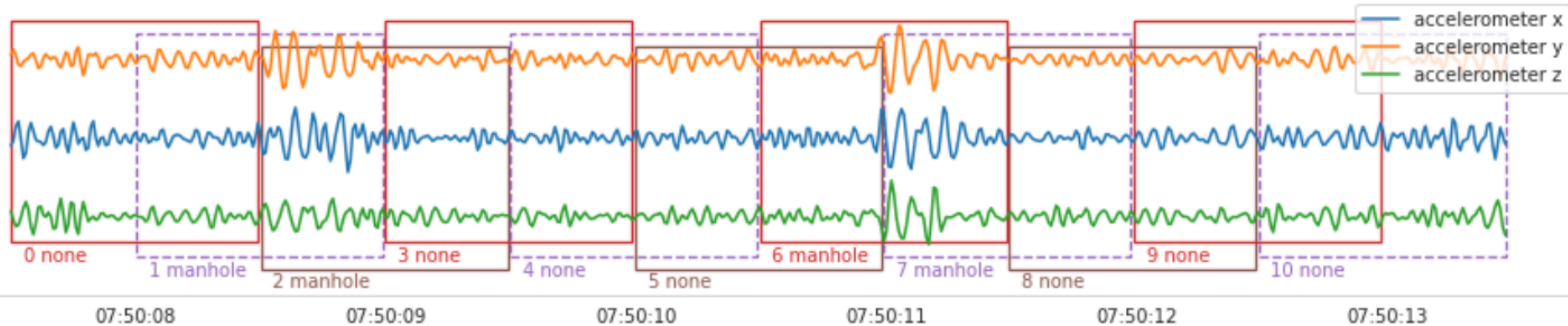
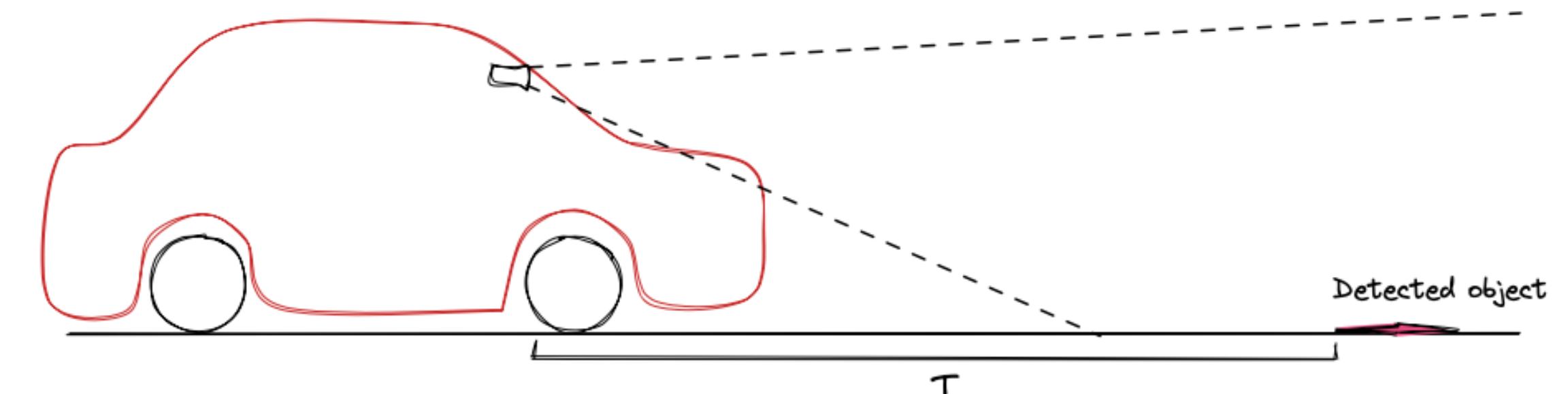


Machine Learning Models



Machine Learning Models

Segmentation



Evaluate Results



Evaluate Results

Has manhole: True

Hybrid Fusion: True

Visual Only: True

Accelerometer Only: True



Has manhole: False

Hybrid Fusion: True

Visual Only: False

Accelerometer Only: True



Has manhole: True

Hybrid Fusion: True

Visual Only: True

Accelerometer Only: True

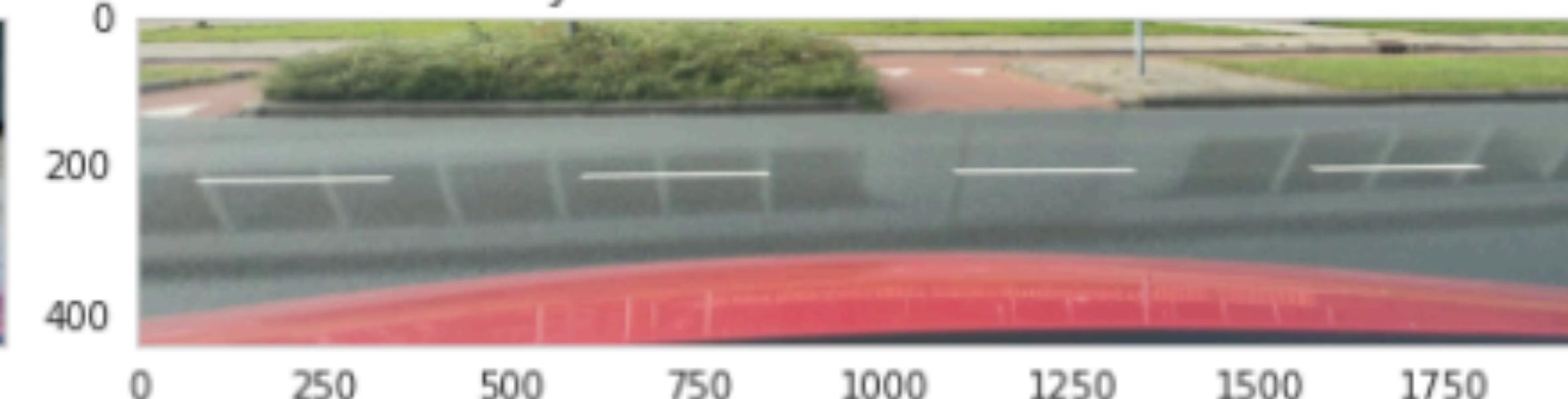


Has manhole: False

Hybrid Fusion: False

Visual Only: False

Accelerometer Only: False



Evaluate Results

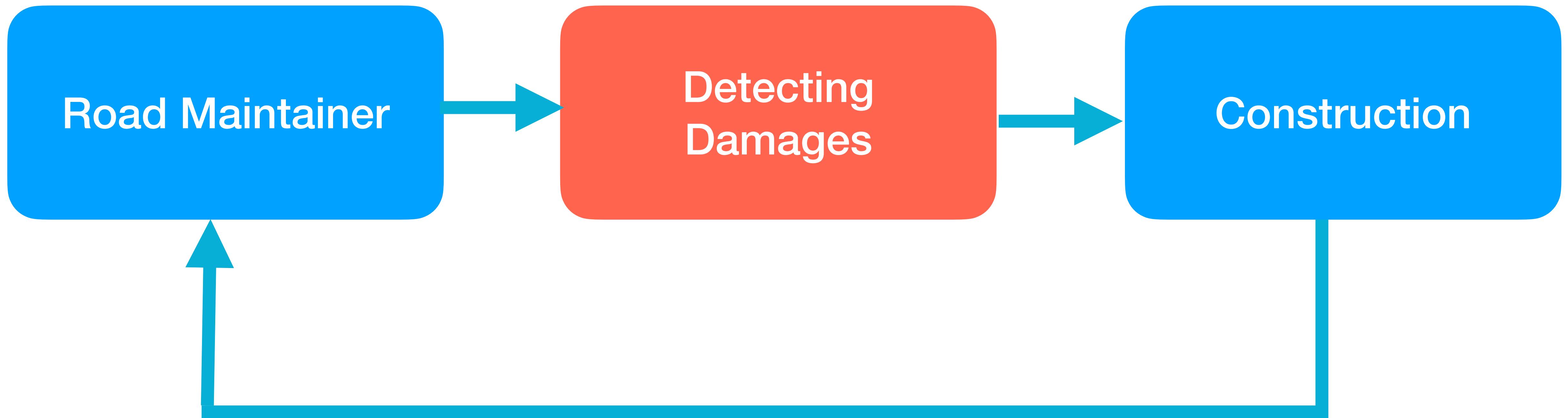
Higher scores mean better performance

Name	Precision	Recall	AP	F1	Parameters
Visual Only	0.86	1.0	1.0	0.93	7,566,817
Accelerometer Only	0.29	1.0	0.61	0.45	35,393
Hybrid Fusion	0.66	1.0	0.88	0.79	7,602,144
Late Fusion	0.62	1.0	1.0	0.77	7,602,210

Concluding

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