Part 4 – Optimization & Benchmarking

To evaluate the improved detection logic, we benchmarked Version 1 (V1) and Version 2 (V2) on the same sample datasets.

Dataset description:
The **first dataset** contains a mostly stable baseline punctuated by two sustained rises in temperature and smoke and two sharp, isolated spikes that represent unrealistic single-point sensor noise.
The **second dataset** represents a complex scenario starting with a high-wind event, followed by a slow-burning fire where smoke levels increase significantly alongside a gradual temperature rise.

Behavior comparison:

- **V1 (original algorithm)** relies on smoothed signals and **variance-aware statistical anomaly scoring with dynamic damping**, which reduces sensitivity in low-variance environments and often mitigates isolated noise. However, in this dataset, two sharp single-point spikes were still strong enough to influence the statistics and trigger alerts. As a result, V1 produced alerts during both sustained rises and also reacted to these spikes, leading to alerts across three episodes instead of the expected two.

- **V2 (improved algorithm)** introduces **single-point spike suppression** during preprocessing and **alert hysteresis** to emit only one alert per sustained high-risk incident. This allows V2 to ignore spike-induced anomalies and generate exactly one alert for each true sustained rise, matching the underlying behavior of the data.

Benchmark results:

Version + Test	Processor Time (ms)	Detector Time (ms)	Total Time (ms)	Events Detected
V1 - Test 1	1.823	2.846	4.669	16
V2 - Test 1	2.315	2.308	4.623	2
V1 - Test 2	2.469	2.808	5.277	14
V2 - Test 2	2.240	2.500	4.740	1

Quality metric:
The primary quality metric is the number of detected events. In test 1, V2 reduces alert count from 16 to 2, significantly lowering alert noise and false positives while preserving detection of genuine incidents.

Performance impact:
The runtime difference between V1 and V2 is negligible, confirming that the system reduces false positives with an insignificant impact on performance.