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NOTE: The authors have declared that no competing interests exist.

NOTE: this paper is on our data set.

Dataset: <https://github.com/jair-jr/driverBehaviorDataset>

Link: <https://journals.plos.org/plosone/article/metrics?id=10.1371/journal.pone.0174959>

Accuracy: from 0.980 to 0.999 after more than 5 tryes.

**Some Notes:**

. The machine learning algorithms (MLAs) employed in these papers come down to fuzzy logic or variations of Dynamic Time Warping (DTW). Dynamic Time Warping is an algorithm to find similar patterns in temporal series. It was originally employed in the speech recognition problem.

Several driver behavior profiling work use a smartphone based sensor-fusion to identify aggressive driving events (e.g., aggressive acceleration, aggressive break) as the basis to calculate driver score.

Driver monitoring and analysis or driver behavior profiling is the process of automatically collecting driving data (e.g., speed, acceleration, breaking, steering, location) and applying a computational model to them in order to generate a safety score for the driver. Driving data collection may be achieved by several kinds of sensors, from the general ones in smartphones, to dedicated equipment such as monitoring cameras, telematics boxes, and On-Board Diagnostic (OBD) adapters.

. It uses the smartphone accelerometer to detect potholes/bumps.

 and the GPS/global system of mobile (GSM) communications to obtain vehicle localization and speed. Braking, bumps and potholes are detected by comparing a set of empirically predefined thresholds to abrupt variations of accelerometer data or to their mean over a sliding window of N seconds.

Dai and colleagues [[9](https://journals.plos.org/plosone/article?id=10.1371/journal.pone.0174959#pone.0174959.ref009)] propose an Android application aimed at real time detection and alert of dangerous driving events typically related to Driving Under the Influence (DUI) of alcohol.

**Projects: (examples)**

An iPhone application called MIROAD was created by Johnson and Trivedi [[10](https://journals.plos.org/plosone/article?id=10.1371/journal.pone.0174959#pone.0174959.ref010)]. MIROAD uses a smartphone based sensor-fusion of magnetometer, accelerometer, gyroscope, and GPS to detect aggressive driving events and accordingly classify driver’s style into aggressive or nonaggressive. Aggressive events are detected by a single classifier based on the DTW algorithm. All processing is executed in real-time on the smartphone. Experimental analysis shows that 97% of the aggressive events were correctly detected.

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Eren et al. [[11](https://journals.plos.org/plosone/article?id=10.1371/journal.pone.0174959#pone.0174959.ref011)] propose an iPhone application to classify driver behavior as either safe or risky based on risky driving events. The application detects sudden turns, lane departures, braking and acceleration events. The sensors used for event detection are the smartphone accelerometer, gyroscope, and magnetometer. The application uses the endpoint detection algorithm to demarcate start and end times of an event. The demarcated event is then compared with template event data by means of the DTW algorithm. Finally, a Bayesian classifier labels a driver’s behavior as safe or risky based on the number of events over time. Experimental results show that 14 out of 15 drivers (93.3%) were correctly classified. It is worth noting that the paper only provides driver classification results. Hence, event classification performance results are not provided.

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Castagnoli et al. [[12](https://journals.plos.org/plosone/article?id=10.1371/journal.pone.0174959#pone.0174959.ref012)] propose a driver behavior profiling mobile tool based on fuzzy logic that makes use of accelerometer, magnetometer, and gravity sensors in Android smartphones. This tool classifies driver behavior as Normal, Moderate, and Aggressive, which correspond to a driving score between 0 (best) and 100 (worst). The classification and score are not processed in real-time as sensor data are collected by UBI-Meter mobile application and stored locally on the smartphone. Later on, these data are sent to a remote server on the Internet for processing. The work by Saiprasert and collaborators [[13](https://journals.plos.org/plosone/article?id=10.1371/journal.pone.0174959#pone.0174959.ref013)] employs GPS, accelerometer, and magnetometer smartphone sensors to profile driver behavior as Very Safe, Safe, Aggressive, and Very Aggressive. This profile is calculated in real-time by detecting relevant driving events. Event detection is performed by a variation of the DTW algorithm [[20](https://journals.plos.org/plosone/article?id=10.1371/journal.pone.0174959#pone.0174959.ref020)].

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Sense Fleet, proposed by Castagnoli et al. [[14](https://journals.plos.org/plosone/article?id=10.1371/journal.pone.0174959#pone.0174959.ref014)], is a driver behavior profiling platform for Android smartphones that is able to detect risky driving events independently from the mobile device and vehicle. The mobile application collects data from accelerometer, magnetometer, gravity sensor, and GPS smartphone sensors and makes use of a fuzzy system to detect risky events such as excessive speed, turning, acceleration, and breaking that might occur in a trip. The application calculates a driving score between 0 (worst) and 100 (best) for each trip as a function of detected risky events. All processing is done in real-time on the smartphone. Authors performed several experiments. In one of these experiments, more than 90% of risky events were correctly identified by the application.

**Future work:**

As future work, we expect to collect a greater number of driving events samples using different vehicles, Android smartphone models, road conditions, weather, and temperature. We also expect to add more MLAs to our evaluation, including those based on fuzzy logic and DTW. Finally, we intend use the best evaluation assemblies observed in this work to develop an Android smartphone application which can detect driving events in real-time and calculate the driver behavior profile.

**Machine learning algorithms**

### Artificial neural networks

### Support vector machines

### Random Forrest

### Bayesian networks