Using Random Forest to Test If Two-Wheeler Experience Affects Driver Behavior When Interacting With Two-Wheelers

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Abstract

Drivers are often at-fault in collisions with powered and unpowered Two-Wheelers (TW). In this paper, we propose a framework based on the random forest algorithm to investigate whether TW experience influences driver interactions with TWs. Sixty-nine drivers completed a 10-minute driving simulator session which included five interactions based on common car-TW crash types. The TWs were initially positioned in front of, or at right angles to, the driven vehicle. The proposed framework detected a statistically significant difference between drivers with TW experience and those without despite the small sample size.

Background

Failure to give way by motor vehicles is a factor in many serious collisions with both powered and unpowered two wheelers (TWs). Motor vehicle drivers often report that they did not see the TW, but research has shown that motor vehicle drivers who have experience riding a motorcycle are less likely to be involved in motorcycle crashes or be at fault (Brooks & Guppy, 1990; Magazzu et al., 2006). It is not known whether bicycle riding experience has the same protective effect. The research reported here examines whether this phenomenon extends to all types of TW experience.

Method

A total of 69 participants with car-only (n=19), car plus motorcycle (n=18), car plus bicycle(n=15), and car plus bicycle plus motorcycle (n=17) experience (later categorised as Car-only and TW-experienced) completed a 10-minute session in the CARRS-Q advanced driving simulator. The driving scenario comprised an Australian urban setting which included five interactions based on common car-TW crash types.

Framework

We defined an interaction period (IP), which covers the driver interaction between the TW. Several measures of speed and time to collision (TTC) were calculated within the IP as shown in Table 1.

Table 1: Measures applied to create features

Measure	Measure
min(diff(driven car speed))	min(diff(TTC))
max(diff(driven car speed))	max(diff(TTC))
mean(diff(driven car speed))	mean(diff(TTC))
Standard deviation of (diff(driven car speed))	Standard deviation of(diff(TTC))
mean(driven car speed)	mean(TTC)
Standard deviation of (driven car speed)	Standard deviation of(TTC)

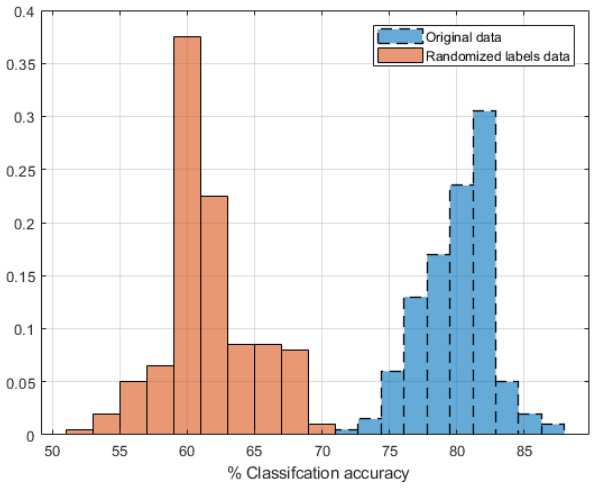
*diff is the first difference function

In this paper, we test the null hypothesis that TW experience does not influence drivers when interacting with a TW. The sample size is small, making it difficult to detect any differences between the two groups of drivers using traditional statistical tests. Therefore, we used the random forest algorithm to train a classifier that predicts whether drivers have TW experience based on the measures

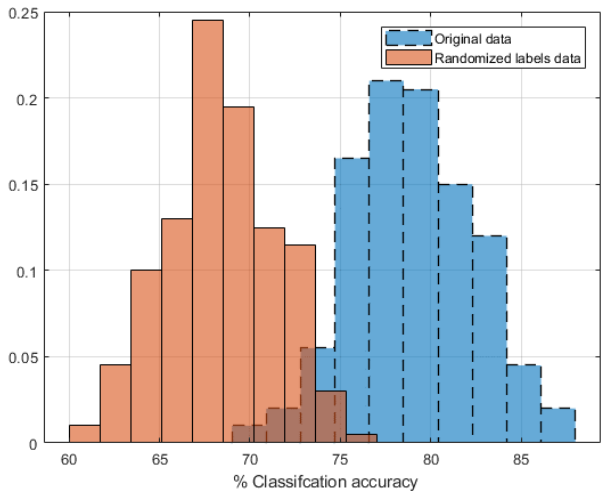
of TTC and driven car speed extracted from the IP. This tests the association of the assigned driver's labels $y \in \{1,2\}$ based on their riding experience with one type of two-wheeler and the values of the measures vectors x observed inside the IP. Evidence exists of an association between x and y if the multi-dimensional distribution of x differs between the driver categories. In other words, if the x has discriminative power to classify the two driver categories then we can obtain a classifier that has classification accuracy greater than the one trained using the same dataset but with randomly permuted labels.

Result and conclusion

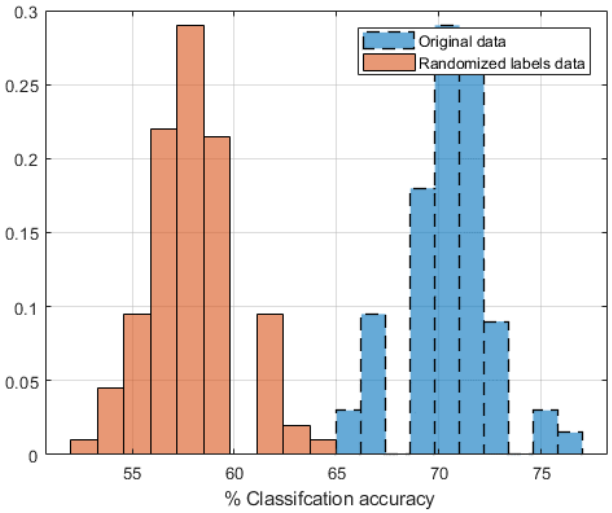
The proposed framework was used to test the null hypotheses for each interaction separately. Figure 1 demonstrates the clear separations between classification histograms for the original data and the permuted data for each interaction. Moreover, the p-value of the two-sample t-test of each interaction is < 0.0001. These results show the features, which are extracted from the speed and TTC within the IP, can discriminate between drivers with and without TW experience. Therefore, we conclude that TW experience influences drivers' interactions with TWs.



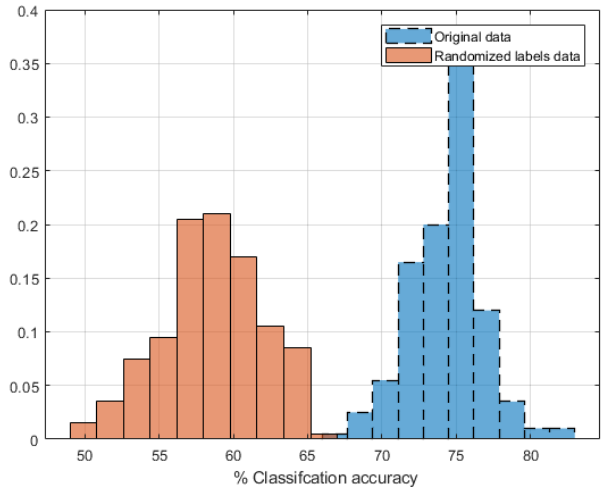
(a) Interaction 1 - driver turns right across the bicycle's path of travel



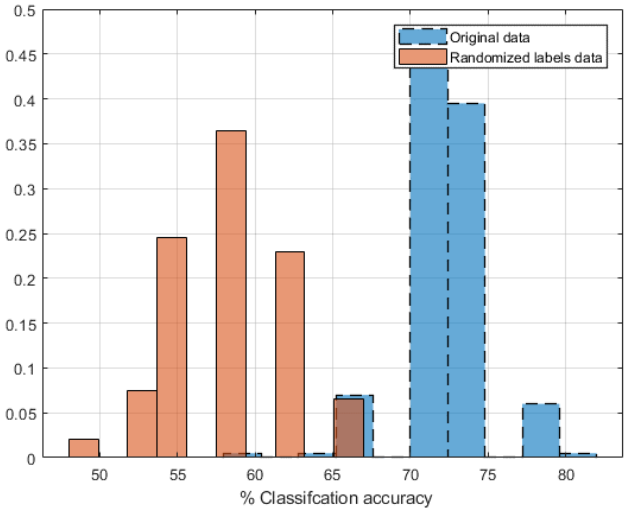
(b) Interaction 2 - driver turns right across the motorcycle's path of travel at an unsignalised intersection



(c) Interaction 3 – driver enters roundabout on which motorcycle was travelling



(d) Interaction 4 - driver enters roundabout on which cyclist was travelling



(e) Interaction 5 - driver turns left to exit from roundabout with cyclist travelling in the left lane

Figure 1. The classification accuracy histogram of the original data and the permuted data

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References

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Magazzu, D., Comelli, M. & Marinoni, A. (2006). Are car drivers holding a motorcycle licence less responsible for motorcycle–car crash occurrence? A non-parametric approach. *Accident Analysis and Prevention, 38*, 365–370.