Human-AI Model: Working Together to Make Handover Situations Safer

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Introduction and Background

- In autonomous driving, a **handover** is a transfer of control.[1]
- Our **goal**: make handovers safer.
- Currently, hand-coded handover rulers often do not consider driver's ability or condition.[2]
- Our system learns the quality of the human's and the autonomous controller's driving ability.

Proposed Method

- Using a high-fidelity driving simulator, we collected real human driving behavior.
- We also collected the driving behavior of the autonomous controller.

Figure 1.0 Driving simulator used to collect data.

- We stored the following data:
  1. Steering wheel angle.
  2. Stability of the vehicle.
  3. Driver's ability represented by cost.
- We aim to learn how good or bad each driver is (i.e., human or autonomous controller).
- Therefore, we use regression to model the cost of each driver.

Setup:

- There are 2 models; one for the human driver and the other for the autonomous controller.
- State features: steering wheel angle, stability of the vehicle (four features).
- Output: the driver's ability represented by the cost variable.

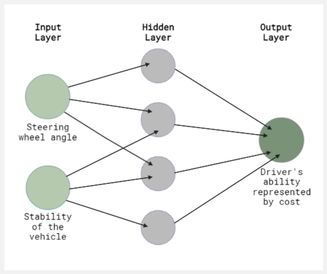

Figure 2.0 Diagram of a neural network regression model.

Research Questions

- How well can supervised learning models learn the driving data?
- How does the learning rate affect the performance of the driving models?
- Who is better at driving (human or autonomous controller)?

Results

- To determine who is better at driving, we can start by looking at which model is better at learning the data.

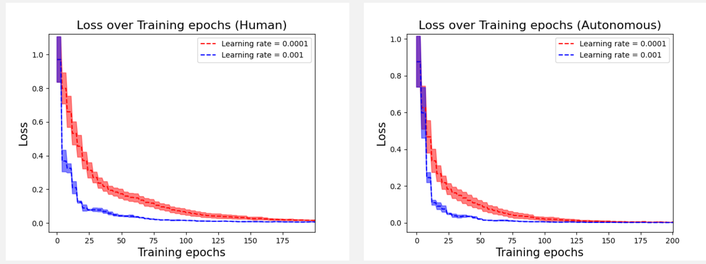

Figure 3.0 We can check how each model is learning by plotting the loss for the human driver (left) and autonomous controller (right).

- Loss reaches zero ⟶ Model fully trained.
- The learning rate affects the models' performance.
  - The figure above shows the autonomous controller model learning data better than the human (not always).

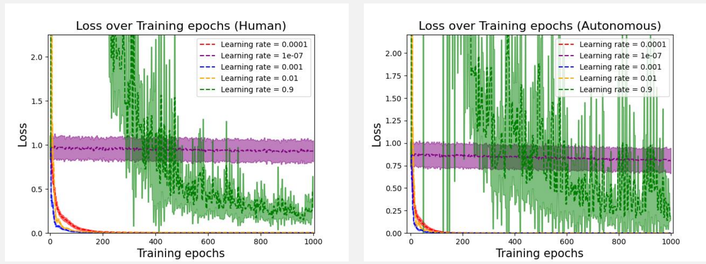

Figure 4.0 We can see how the learning rate affects the performance of the human (left) and autonomous (right) models.

- The figure above shows:
  - Very high learning rate (0.90): does not stabilize.
  - Very low learning rate (1.0e-7): does not reach zero fast.
  - Learning rate (0.01): starts very high.
  - Learning rates (0.0001 and 0.001): improve the models' performance the most.
- We can also look at the difference between the predicted value and the true value for both drivers and determine who is better at learning the data.

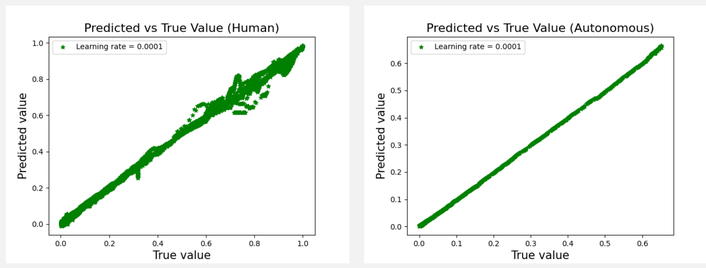

Figure 5.0 We can check the accuracy of the model by plotting the predicted values and the actual values together for the human (left) and autonomous controller (right).

- The autonomous controller model predicts more accurately than the human model in the figures above.
  - The plot is a lot noisier in the human data because humans cannot replicate the same action again.

- To determine who is better at driving we can look at the total cost over a time period for the learning rates shown in *figure 3.0* (0.001 and 0.0001).

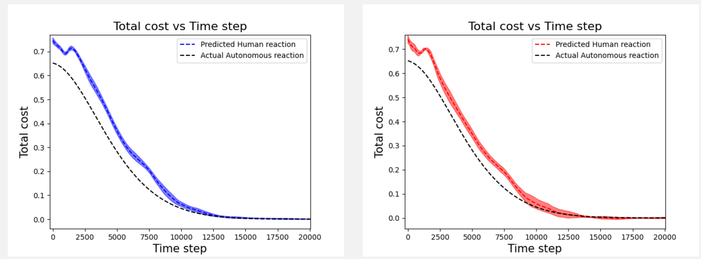

Figure 6.0 We can predict the cost of the human driver (blue/red) and compare it to the actual cost of the autonomous controller (black).

- The figure above shows the comparison between the human driver and the autonomous controller.
- The autonomous controller would able to control the driving situation better than the human.

Conclusions

- Our regression models can learn to predict human or autonomous controller driving performance.
- The learning rate plays an important role in the speed of learning and the final accuracy of the model.
- In situations tested, we predict the autonomous controller was better at driving than the human.
- Our future work will consider other settings where the human can outperform the autonomous controller, using our model to decide when the car should handover control to the human.

References

1. B. Liu, G. Rong, L. Dong, H. Zhang, D. Chen, T. Chen, Y. Chen, T. Zhang, "What are the factors affecting the handover process in open-source development? *ScienceDirect,* April 2019, https://www.sciencedirect.com/science/article/pii/S0164121219300718?ref=pdf_download&fr=RR-2&rr=7ed690de8ba2b608

2. R. McCall, F. McGee, A. Mirnig, A. Meschtscherjakov, N. Louveton, T. Engel, M. Tscheligi, "A taxonomy of autonomous vehicle handover situations," *ScienceDirect*, June 2019, https://www.sciencedirect.com/science/article/pii/S0965856417311072

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