AuE-8930 Deep Learning Final Project Proposal

# Team Members (Group 4)

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# Tentative Project Title

Data-Driven Discovery of Vehicle Motion Model using Bayesian Deep Learning

# Problem Statement

Motion models are crucial for simulation and state estimation purposes and can be either developed using traditional or learning-based methods. On one hand, formal methods such as first-principles modeling are interpretable and explainable but require extensive system identification for parameter tuning and may result in computationally complex models. On the other hand, simple data-driven methods such as end-to-end learning can capture the dynamics to certain extent with low-latency inference, but their interpretability and explainability may be questionable. This work will investigate whether Bayesian deep learning can help bridge the gap between formal and data-driven approaches to develop computationally light-weight surrogate models that are generalizable, interpretable, and explainable. Particularly, we will be using the proposed approach to “learn” a reduced-order (i.e., surrogate) motion model of an Ackerman-steered vehicle given its low-level control inputs such as throttle, brake and steering.

# Work Breakdown Structure

Following are the three phases planned for the project:

1. **Phase 1: Data Collection**
   * Shortlist control inputs and states to be measured/estimated
   * Collect dynamical dataset of an Ackerman-steered vehicle
   * Post-process the dataset to get required features and labels
2. **Phase 2: Model Training**
   * Define architecture of Bayesian neural network
   * Define/tune hyperparameters
   * Train and save the model
3. **Phase 3: Model Inference**
   * Forward-simulate the trained model by providing control inputs to it
   * Benchmark the model against ground-truth and comment on its validity

# Detailed Schedule

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| --- | --- | --- | --- |
| **Week** | **Day** | **Task** | **Deliverables** |
| **10** | **3/13** | **Draw up the schedule** |  |
| **3/17** | **Draw up the schedule** |  |
| **11** | **Spring break** | **Write project proposal** |  |
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| **12** | **3/27** | **Submit proposal** | **Detailed proposal (2~3 pages)** |
| **3/31** | **Review of the project proposal** |  |
| **13** | **4/3** | **Data acquisition** |  |
| **4/7** | **Data acquisition** |  |
| **14** | **4/10** | **Data acquisition and processing** |  |
| **4/14** | **Data acquisition and processing** | **Interim project report (1~2 pages)** |
| **15** | **4/17** | **Model building and training** |  |
| **Midterm** | **Model building and training** |  |
| **16** | **4/25** | **Model test and validation** | **Final codebase** |
| **4/28** | **Documentation** | **Final project report (5~10 pages)** |
| **17** | **5/2** | **Final project presentations** | **Final project slides (5~10 slides)** |
| **5/4** | **Final project presentations** |  |

# Submission Deliverables

* Source code
* Project report
* Presentation slides