ABSTRACT

Name of student: **Sivasankar A** Roll no: **22103068**

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Thesis title: **Traffic State Estimation using Physics Informed Deep Learning**

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Traffic state estimation (TSE) reconstructs the traffic variables (e.g., density, speed and flow) on road segments using partially observed data. TSE approaches can be broadly categorized into model-driven and data-driven methods. Model-driven methods depend heavily on established physical traffic flow models like Lighthill-Whitham-Richards (LWR) and cell transmission model (CTM). However, these models may only capture a limited range of real-world traffic dynamics and rely on fundamental diagram assumptions. On the other hand, data-driven approaches require large amount of data. To address the limitations, a physics-informed deep learning (PIDL) framework which contains both model-driven (based on integral form of the conservation law and hydrodynamic relationship) and data-driven components are implemented. The loss function of PIDL consists of two parts: 1) physics loss and 2) data-driven loss which

helps in guiding to give an accurate estimation of traffic state. The physics loss accounts for the conservation law of vehicles while data loss gives the ground truth values to the model which together resulting in reasonable TSE even in unavailability of large field data. Loop detector data from freeway A5 Frankfurt, Germany is used for the study. The reconstruction of traffic state using PIDL is compared qualitatively with data interpolation technique known as adaptive smoothing method (ASM), which employs kernel filters for both congested and free traffic based on traffic wave propagation speed and preserves the domain of dependency. The PIDL makes better estimations of traffic state compared to ASM method especially near the on-ramp and off-ramp locations. Moreover, predictions of traffic flow are more reliable compared to ASM and this limitation arises due to error accumulated from the density estimations in ASM which relies heavily on interpolation and smoothing techniques. However, in order to generalize these results, we can extend PIDL method using dataset from different locations by testing and comparing with ASM.