Formalisation of Traffic Rules for Automated Vehicles with BDI–Logics

Motivation

Recently[1], one of Google's Autonomous Vehicles (AV) collided with a bus in California when driving autonomously. This is the first time Google acknowledges that its AV is liable. How should we decide when an AV is liable when a collision occurs? What if the AV obeys all traffic rules when the collision occurs? Should it be held liable? If not, how could we then design an AV which always obeys traffic laws? Could Artificial Intelligence (AI) solve this problem? If AI can, what elements of AI do we need to solve this problem?

Image taken from `independent.co.uk`

Description

Our idea to solve this problem is by using Knowledge Representation (KR) technique in AI. We wish to formalise traffic laws in an explicit representation (logic) such that each traffic rule is *precise* and verifiable. This eases the technology provider, like Google, to implement their AVs because they have a clearer understanding of what traffic laws are stipulating. In this thesis, we choose to formalise the Vienna Convention of Traffic Rules.

If we analyse the applicable rules from the Vienna Convention, many of them regulates the *desires* and *intentions* of a driver. In the literature, one of the most prominent logic for reasoning about desires and intentions is Rao and Georgeff's BDI (Beliefs–Desires–Intentions) logic. Therefore, we will use BDI–logic to formalise the traffic rules from the Vienna Convention.

Tasks

1. Encode Rao and Georgeff's BDI logic (syntax and semantics) in Isabelle/HOL.

2. Specify formally a subset of traffic rules with BDI logic in Isabelle/HOL.

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[1]Google Inc. *Google Self-Driving Car Project Monthly Report February 2016.* Tech. rep. Alphabet, 2016.