A Methodology for Runtime Assessment of the Quantitative Risk Norm for ADSs

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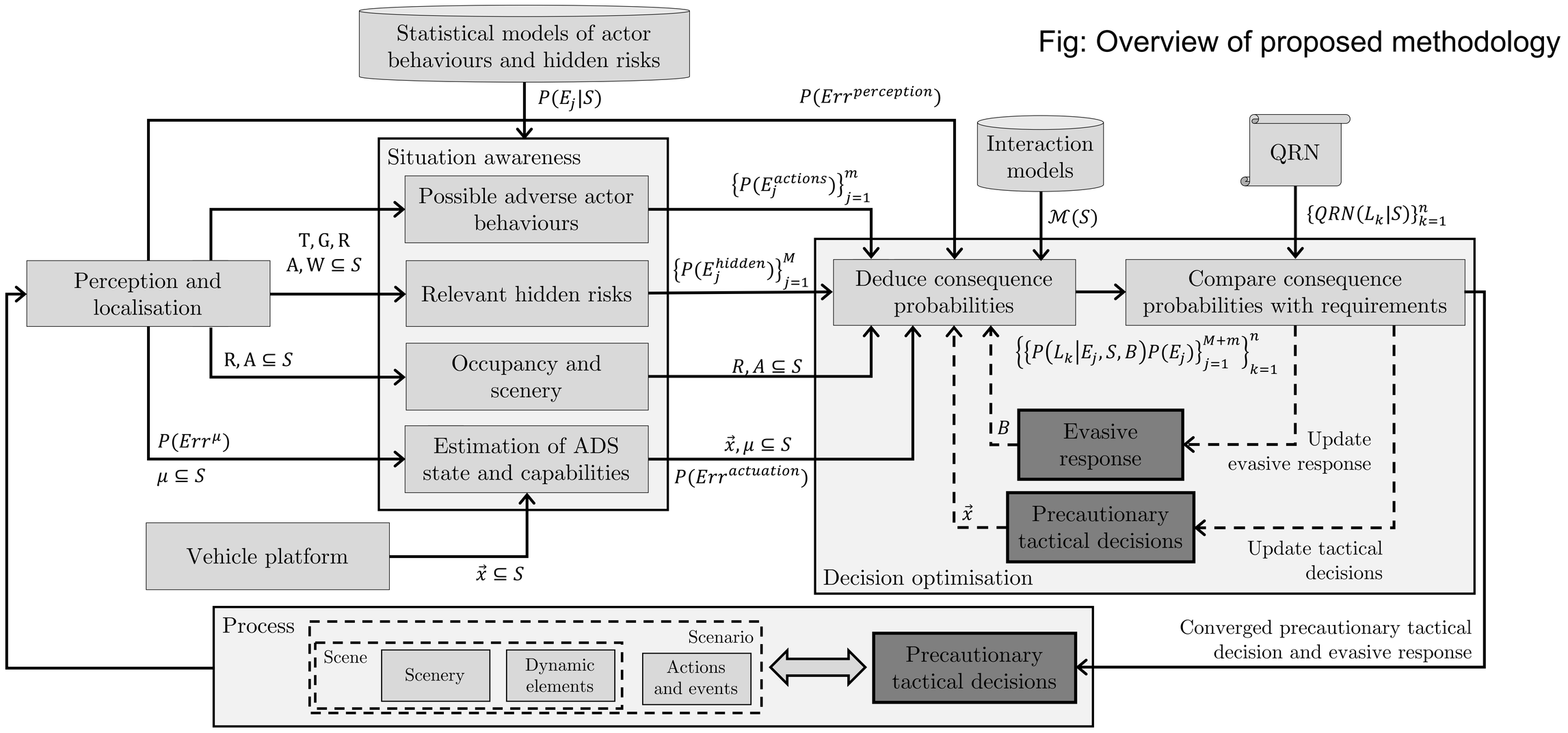
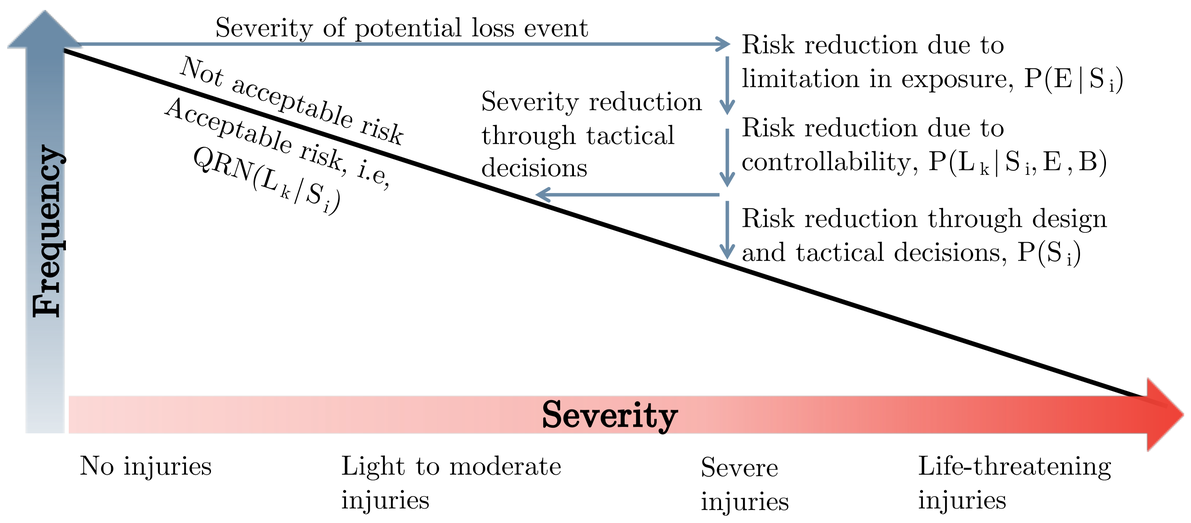
Abstract

We present a methodology that links the precautionary driving policy of an Automated Driving System (ADS) to knowledge of the fulfilment of a Quantitative Risk Norm (QRN) – at runtime. This methodology, shaped around a novel formulation for assessing the fulfilment of the QRN, helps elucidate the importance of different key contributing factors. Further, the associated assessment framework enables the QRN assessment to be done at runtime, while the ADS accounts for its own capability, external conditions as well as the controllability of adverse events – both by the ADS as well as through interactions with other road users.

Fig: Overview of proposed methodology



Fulfilling the QRN



The risk of a loss event is traditionally including severity, controllability and exposure (as per ISO 26262). How the terms of proposed methodology relates to these three factors is illustrated in the figure above. The frequency of occurrence of the loss event can be modulated by a reduction in exposure, increased controllability (i.e. the ability of the ADS or other traffic participants to avoid the negative outcome), and through design choices limiting the effective exposure to the type of scenes associated with the specific loss event (c.f. ODD restrictions). Additionally, the severity of the loss event could also be reduced through appropriate tactical decisions, which is what we explore and propose through the methodology presented.

Eval: Rear-end and jaywalker

To evaluate the proposed methodology, we consider a case study with two different loss events and one adverse event. The adverse event come in the form of a jaywalking pedestrian entering the road, which is also associated with one of the loss event types. Secondly, to elucidate the connection to an enriched situation awareness of the ADS, we also consider the presence of a trailing vehicle, which might result in a rear-end collision. The evasive response (i.e. the braking amplitude a_{ADS}) impact the maximum velocity with which the ADS can travel while still fulfilling the QRN. Without a trailing vehicle present (the yellow dash-dotted line) the ADS would be allowed to enact larger braking forces, enabling a more efficient avoidance of jaywalkers.