In this paper a novel methodology for the prediction of the occurrence of road accidents is presented. The methodology utilizes a combination of three statistical methods: (1) gamma-updating of the occurrence rates of injury accidents and injured road users, (2) hierarchical multivariate Poisson-lognormal regression analysis taking into account correlations amongst multiple dependent model response variables and effects of discrete accident count data e.g. over-dispersion, and (3) Bayesian inference algorithms, which are applied by means of data mining techniques supported by Bayesian Probabilistic Networks in order to represent non-linearity between risk indicating and model response variables, as well as different types of uncertainties which might be present in the development of the specific models. Prior Bayesian Probabilistic Networks are first established by means of multivariate regression analysis of the observed frequencies of the model response variables, e.g. the occurrence of an accident, and observed values of the risk indicating variables, e.g. degree of road curvature. Subsequently, parameter learning is done using updating algorithms, to determine the posterior predictive probability distributions of the model response variables, conditional on the values of the risk indicating variables. The methodology is illustrated through a case study using data of the Austrian rural motorway network. In the case study, on randomly selected road segments the methodology is used to produce a model to predict the expected number of accidents in which an injury has occurred and the expected number of light, severe and fatally injured road users. Additionally, the methodology is used for geo-referenced identification of road sections with increased occurrence probabilities of injury accident events on a road link between two Austrian cities. It is shown that the proposed methodology can be used to develop models to estimate the occurrence of road accidents for any road network provided that the required data are available.
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