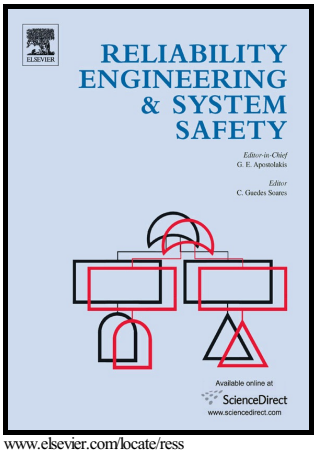

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PII: S0951-8320(16)31010-9
DOI: http://dx.doi.org/10.1016/j.ress.2016.12.012
Reference: RESS5719

To appear in: *Reliability Engineering and System Safety*

Received date: 26 April 2016
Revised date: 4 November 2016
Accepted date: 20 December 2016

Cite this article as: Iván Cárdenas-Gallo, Carlos A. Sarmiento, Gilberto A Morales, Manuel A. Bolivar and Raha Akhavan-Tabatabaei, An ensemble classifier to predict track geometry degradation, *Reliability Engineering and System Safety,* http://dx.doi.org/10.1016/j.ress.2016.12.012

An ensemble classifier to predict track geometry degradation

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Abstract

Railway operations are inherently complex and source of several problems. In particular, track geometry defects are one of the leading causes of train accidents in the United States. This paper presents a solution approach which entails the construction of an ensemble classifier to forecast the degradation of track geometry. Our classifier is constructed by solving the problem from three different perspectives: deterioration, regression and classification. We considered a different model from each perspective and our results show that using an ensemble method improves the predictive performance.

Keywords: Railroad maintenance, Defects, Gamma process, Logistic regression, Support vector machines, Classification, Ensemble algorithms

1. Introduction

Railroads account for approximately 40 percent of intercity freight volume in the United States - more than any mode of transportation (AAR, 2015). Moreover, Amtrak, the National Railroad Passenger Corporation transports an average of 86000 passengers every day. Therefore, analyzing track geometry defects is critical for keeping freight and passenger trains moving safely. According to the US Federal Railroad Administration Office of Safety Analysis (FRA, 2014), track defects are one of the leading causes of train accidents in the United States. Furthermore, among the 1747 train accidents that happened in 2012, nearly 33% (577) were caused by track defects, resulting in a total reportable damage of $102.9 million (Peng et al., 2013).

To address this problem, every year North American railroads spend millions of dollars on periodic rail inspection. A fleet of track geometry vehicles travel across the railroad network and examine rail tracks for external and internal rail defects using visual inspection and technologies such as induction and ultrasonic devices (Cannon et al., 2003). Additionally, they are equipped with Global Positioning System (GPS) to accurately identify the location where measurements are taken. These vehicles have the ability to identify around 40 different types of track geometry defects, which indicate severe conditions in some key geometry parameters such as profile, alignment, gage, twist, etc. Those defects are classified into two severity levels - red tags and yellow tags (Cannon et al., 2003). Red tag defects violate the Federal Railroad Administration (FRA) track safety standards and must be fixed as soon as possible. Yellow tag defects satisfy FRA standards; however, they will eventually become red tag defects if they are not fixed. Ability to predict when these yellow tag defects would evolve into red tags, allows railroads administrators to more efficiently maintain the rail and remain in FRA compliance.