Title

AI's Transformative Power: NLP for Next-Generation Actuarial Risk Assessment

Speaker/Company

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Abstract

Traditional actuarial models, such as Generalized Linear Models (GLMs), present significant limitations in fully capturing the complexity of risk and loss events. These models exhibit deficiencies in personalization, complex pattern identification, and loss event classification, primarily due to their dependence on structured data and limited flexibility in analyzing policyholder relationships.

This research presents an advanced Natural Language Processing (NLP) solution designed to overcome these limitations through semantic context extraction from unstructured claim texts, identifying hidden risk factors that extend beyond conventional structured variables.

The developed methodology utilizes BERTopic for advanced topic modeling, implementing a four-stage process: embedding generation, dimensionality reduction, clustering, and topic representation. This approach enables the discovery of recurring patterns and typical incident scenarios within large textual volumes.

To ensure accuracy and relevance, domain-specific fine-tuning of generalist NLP models (such as GPT2-Small) has been implemented on synthetic insurance Q&A pairs, effectively addressing the challenge of specialized technical insurance language.

The application of this methodology to real-world crash data (NMVCCS dataset) has demonstrated the ability to identify and transform semantic patterns into operational actuarial risk profiles. Key findings include:

The identification of high-risk patterns: sequences such as "Vehicle → Driver → Event → Coded" show a 20.2% fatality rate. Demographic risk profiling has identified high-risk groups including males aged 36-45 and 65+ (Risk Score 1.79). A Volume vs. Risk Paradox highlights discrepancies between event frequency and severity. Gender-specific patterns reveal that males show higher crash frequency while females experience greater injury severity in comparable crashes.

The solution offers substantial benefits for actuaries:

Context Enhancement enables the extraction of deep insights from unstructured texts that enrich traditional analysis. Smart Clustering provides intelligent claim grouping based on semantic patterns rather than numerical variables alone. Improved Risk Quantification establishes direct connections between incident scenarios and measurable risk profiles. Enhanced Fraud Detection identifies suspicious linguistic patterns through advanced semantic analysis.

The complex models and generated insights are presented through a dedicated interactive dashboard that facilitates in-depth exploration and strategic application in targeted underwriting, pricing, and

comprehensive risk management. The source code for this innovative approach is available for further exploration and development.

Biography

Manuel Caccone is a seasoned professional with over 8 years of comprehensive experience in the insurance and actuarial sector. Throughout his career, he has held pivotal roles at Gruppo Unipol, serving as both Life Risk Manager & Quantitative Actuary and Non-Life Risk Manager & Quantitative Actuary. In these strategic positions, he specialized in critical areas including Internal Model Premium Risk, Catastrophe Modeling, and ORSA Risk Modelling, while pioneering the application of Machine Learning, Big Data analytics, and Python programming for advanced actuarial science and sophisticated risk analysis.

Building upon this solid actuarial foundation, Manuel has transitioned into the Legal Technology sector, where he applies his expertise as a Chief Innovation Officer specializing in intelligent AI solutions for Legal Tech applications. In this capacity, he leads the development and implementation of cutting-edge AI systems, including autonomous agents and Retrieval-Augmented Generation (RAG) systems specifically designed for legal industry applications.

Manuel currently serves as Team Leader for the International Actuarial Association's (IAA) AI Task Force, where he guides strategic initiatives at the intersection of artificial intelligence and actuarial science. As a Senior Actuary, he is widely recognized for his unique expertise in applying AI methodologies across both actuarial and legal domains, bridging traditional risk assessment with innovative technology solutions in the legal services industry.