Emerging Risk Group

Annual Report
2021-22 Academic Year

ERG
EMERGING RISK GROUP

MESSAGE FROM THE DEAN

Originally formed in 2007, the Emerging Risk Group has grown into an exemplar multi-disciplinary research team built upon a strong, collaborative scholastic mentorship programme.

During these turbulent times, I would like to focus on innovation and commercialising technologies and research, teaching and practice and advocating change – though not just change for change sake. What we have gone through over the last eighteen months has been change foisted upon us. This is a change we have embraced and responded to.

Consistent with our founding ethos at the Kemmy Business School, we value industry-relevant, pedagogically-informed and impactful research activity. Embedding our research culture across departments, themes and clusters is important in attracting exceptional faculty and will serve to inculcate an interdisciplinary approach that leads to innovation and a positive impact on our wide range of stakeholders. These activities will build on our funding successes both internationally (e.g. Horizon 2020 and ESRC) and nationally (e.g. SFI and EPA) and invigorate our commitment to Horizon Europe and other funding opportunities both nationally and internationally.

The ERG is comprised of an international team of researchers devoted to advancing the state-of-the-art in areas as diverse as actuarial science, machine learning, ethics, risk management, nanotechnology, smart mobility and cybersecurity. The success of the team during the uncertain AY20-21 period is reflective of the group's core goals to lead positive change in the risk community and beyond.

Prof Finbarr Murphy
Executive Dean KBS
Senior Member ERG
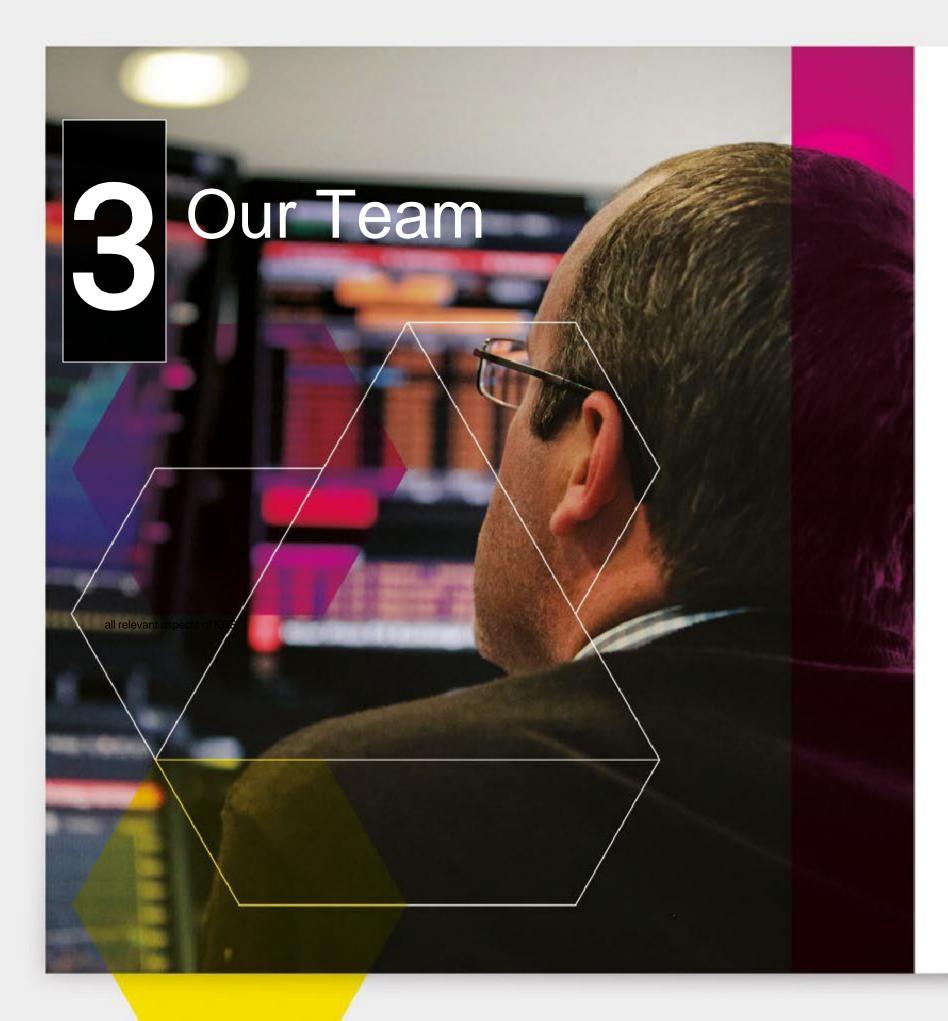
Kemmy Business School
University of Limerick

2 Emerging Risk Group: A Brief History

The Emerging Risk Group (ERG) was developed by founding members Dr. Martin Mullins and Dr. Finbarr Murphy in 2007, to develop a new context of academic research that was informed by private and public knowledge requirements.

The first focus of the group concerned risk metrication in the context of insurance attentive to a changing private and public emerging risk environment and market. Since that time the group has collaborated with SUN and grown in strength to offer a dynamic and unique research model.

One of the key strengths of the ERG is in its ability to respond to an ever-changing dynamic and fluid array of emerging risk fueled by a new paradigm of emerging technologies. To respond to this new phenomenon of emerging technological risk the group has built a collaboration of members that collectively present one of the most unique risk focused knowledge basis and research paradigms on offer today.

ERG has built upon its key areas of insurance, nanotechnologies, cybersecurity and smart mobility to be a part of the new European funded Horizon 2020 consortia concerning the development of Vision Inspired Driving Assistance Systems (Vi-DAS).

3 Our Team

all relevant aspects of KR

Summary

The Emerging Risk Group (ERG) at the University of Limerick has a long-established expertise in insurance and risk management and has a continued success within large research consortia including a number of EU H2020 and FP7 research projects. The group and its members are active participants in international research partnerships and regulatory bodies influencing societal change, such as EIOPA, ERTICO, and CCAM.

Although our primary goal as a team is to emphasise the broader impact that emerging technologies will have on social structures, we thrive off creating innovative solutions to fledgeling issues. We accomplish our commitments by regularly collaborating with established industry leaders, publishing in respected academic journals and participating in conferences.

We have just completed three EU Horizon 2020 research projects with a combined fund of €20 million, with more projects on the horizon. These included two EU H2020 research projects related to semi-autonomous vehicles: VI-DAS (http://vi-das.eu/) and Cloud-LSVA (http://cloud-lsva.eu/). Technical objectives predominately drive these consortia and our role is one of assessing the legal, ethical, and actuarial impacts of ADAS technology. In addition, we were tasked with assessing the risk of nanotechnology applications within the PROTECT (http://protect-h2020.eu/) EU H2020 project. Current active projects include Anti-Fin-Ter (EC-funded), BAV Spoke (SFI-finded) and LIAISON (Government of the Grand Duchy of Luxembourg funded).
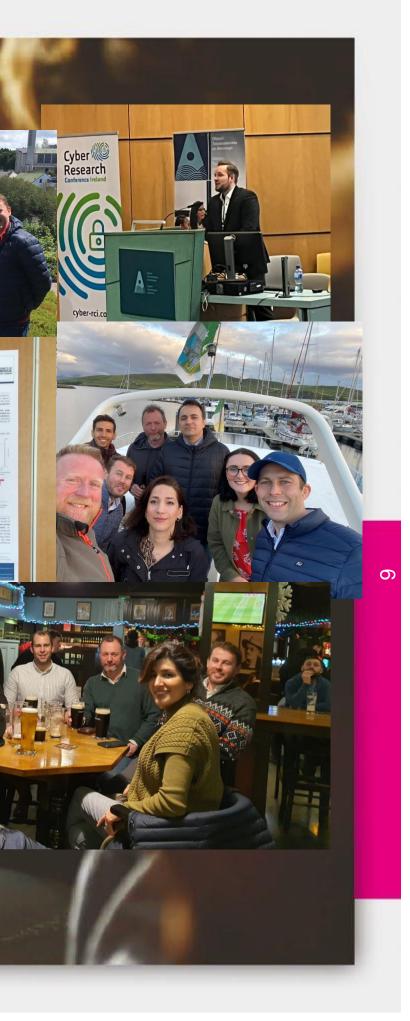
Our Team Today

Our team members are based across Europe and cover a wide array of research areas, including machine learning, actuarial, insurance strategy, legal and ethical considerations of emerging technologies. The Group's network includes close affiliations with national research funding bodies (LERO, CONFIRM, Dublin City Council, the Road Safety Authority), and international research partnerships such as IBM, Honda, Valeo, XL Catlin, Motion-S, Lloyd's of London and many more.

Emerging Risk Group Team:

1) Prof. Martin Mullins
2) Prof. Finbarr Murphy
3) Dr. Darren Shannon
4) Dr. Martin Cunneen
5) Dr. Irini Furxhi
6) Dr. Barry Sheehan
7) Dr. Cian Ryan
8) Dr. Arash Kia
9) Dr. Fabian Pütz
10) Mr. Tim Jannusch

11) Mr. Wei Xu
12) Ms. Mahsa Mirzaei
13) Ms. Juliane Ressel
14) Mr. Florian David-Spickermann
15) Mr. Leandro Masello
16) Mr. Frank Cremer
17) Mr. Kevin McDonnell
18) Mr. Niall O'Donnell
19) Mr. Sean Gaines
20) Ms. Emer Owens

4 Academic Output AY2021-22

A Peer-reviewed Journal Articles

Cremer, F., Sheehan, B., Fortmann, M., Kia, A.N., Mullins, M., Murphy, F. and Materne, S., 2022. Cyber risk and cybersecurity: a systematic review of data availability. *The Geneva Papers on Risk and Insurance-Issues and Practice*, pp.1-39.

Sheehan, B., Humberg, C., Shannon, D., Fortmann, M. and Materne, S., 2022. Diversification and Solvency II: the capital effect of portfolio swaps on non-life insurers. *The Geneva Papers on Risk and Insurance-Issues and Practice*, pp.1-34.

Mullins, M., Holland, C.P. and Cunneen, M., 2021. Creating ethics guidelines for artificial intelligence and big data analytics customers: The case of the consumer European insurance market. *Patterns*, 2(10), p.100362.

Masello, L., Sheehan, B., Murphy, F., Castignani, G., McDonnell, K. and Ryan, C., 2022. From traditional to autonomous vehicles: a systematic review of data availability. *Transportation research record*, *2676*(4), pp.161-193.

Shannon, D. and Fountas, G., 2022. Amending the heston stochastic volatility model to forecast local motor vehicle crash rates: A case study of Washington, DC. *Transportation research interdisciplinary perspectives*, 13, p.100576.

Lannon, C., Nelson, J. and Cunneen, M., 2021. Ethical AI for Automated Bus Lane Enforcement. *Sustainability*, 13(21), p.11579.
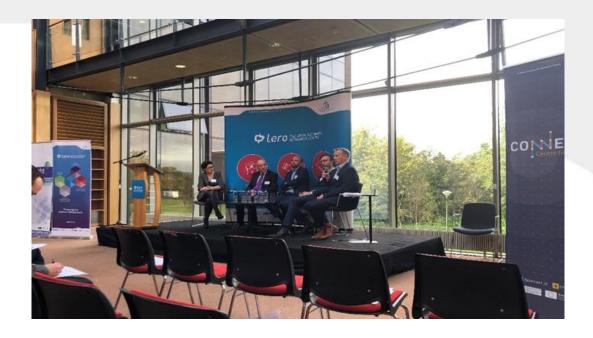
Peer-reviewed Journal Articles (cont'd)

Furxhi, I., 2021. Health and environmental safety of nanomaterials: O Data, Where Art Thou?. NanoImpact, p.100378.

Murphy, F., Alavi, A., Mullins, M., Furxhi, I., Kia, A. and Kingston, M., 2022. The risk perception of nanotechnology: evidence from twitter. RSC advances, 12(18), pp.11021-11031.

Furxhi, I., Perucca, M., Blosi, M., de Ipiña, J.L., Oliveira, J., Murphy, F. and Costa, A.L., 2021. ASINA Project: Towards a Methodological Data-Driven Sustainable and Safe-by-Design Approach for the Development of Nanomaterials. Frontiers in Bioengineering and Biotechnology, 9.

Furxhi, I., Murphy, F., Poland, C.A., Cunneen, M. and Mullins, M., 2021. Precaution as a Risk in Data Gaps and Sustainable Nanotechnology Decision Support Systems: a Case Study of Nano-Enabled Textiles Production. NanoEthics, 15(3), pp.245-270.

Mirzaei, M., Furxhi, I., Murphy, F. and Mullins, M., 2021. A machine learning tool to predict the antibacterial capacity of nanoparticles. Nanomaterials, 11(7), p.1774.

Mirzaei, M., Furxhi, I., Murphy, F. and Mullins, M., 2021. A Supervised Machine-Learning Prediction of Textile's Antimicrobial Capacity Coated with Nanomaterials. Coatings, 11(12), p.1532

Masello, L., Castignani, G., Sheehan, B., Murphy, F. and McDonnell, K., 2022. On the road safety benefits of advanced driver assistance systems in different driving contexts. Transportation research interdisciplinary perspectives, 15, p.100670.

Koivisto, A.J., Del Secco, B., Trabucco, S., Nicosia, A., Ravegnani, F., Altin, M., Cabellos, J., Furxhi, I., Blosi, M., Costa, A. and Lopez de Ipiña, J., 2022. Quantifying Emission Factors and Setting Conditions of Use According to ECHA Chapter R. 14 for a Spray Process Designed for Nanocoatings—A Case Study. Nanomaterials, 12(4), p.596.

Owens, E., Sheehan, B., Mullins, M., Cunneen, M., Ressel, J., Castignani, G. (2022) "Explainable Artificial Intelligence (XAI) in Insurance", *Risks*, 10 (12) 230. doi: https://doi.org/10.3390/risks10120230

Conferences, Presentations, Funding, Awards, Press

Cremer, F. Sheehan, B., Mullins, M., Murphy, F., Fortmann, M (2022): Limits of (re)insurance cover – An analysis of exclusions of cyber-conditions, presented at the 15th Annual Meeting of Sponsoring Group Reinsurance Researchers' Corner, 24 June 2022

Cremer, F. Sheehan, B., Mullins, M., Murphy, F., Fortmann, M. (2022) An investigation into the cyber insurance coverage, presented at Cyber Research Conference Ireland, Galway, April 25th, 2022.

Frank Cremer: Press release Lero calls for improved databases in $1tn fight against cybercrime.
Silicon Republic (Web), 10/03/2022, Business Plus Online (Web), 10/03/2022.

Shannon, D., and Sheehan, B. (2022) How do Equity Investors React to Green Bond Announcements? A Deep Learning Application to Abnormal Returns. World Finance Conference (August 2022)

Ressel, J. (17.03.2022). The relationship between fairness and trust in promoting consumer acceptance of AI in the European insurance industry. Presented at the Annual Conference of the German Association for Insurance Science.

Shannon, D., Sheehan, B., and Masello, L (2022): ClaimRisk Project: Reducing Driver Risk using Technology-based Interventions. Enterprise Ireland Innovation Award enabling academic-industry collaboration.

Owens, E. Explainable Artificial Intelligence and Fair Data Principles in Insurance, CSEAR Virtual Conference (2021)

Ressel, J. (27.09.2021). Virtual presentation of PhD research at KI2021 - 44th German Conference on Artificial Intelligence

Conferences, Presentations, Funding, Awards, Press (cont'd)

Cremer, F: Cyber exclusions: An investigation into the cyber insurance coverage gap (2022). KBS 2022 Spring Seminar Serries, April 5th, 2022.

Furxhi Irini, Oral Presentation at the Nano-week "Evolution of Nanosafety and materials sustainability as we transition into Horizon Europe".20-24 June 2022, Limassol, Cyprus

Furxhi Irini, Virtual Presentation at the 10th International conference on Nanotoxicology (2021)

Furxhi Irini, Chairperson in Bayesian networks, machine learning and predictive modelling session at the European Environmental Toxicology and Chemistry, 3-6 May, virtual conference (2021)

Ressel, J. Trustworthy, ethical, fair - somehow or other? About the acceptance of algorithmic (insurance) decision-making. Keynote speech at the 13. ICIS user group conference, Wiesbaden. (27.10.2022)

Focus on research Dr Barry Sheehan, Lero (Nov 2022). Reinveting the science of risk for a data-centric era. Link: https://www.techcentral.ie/focus-on-research-dr-barry-sheehan-lero/

O'Donnell, N. "From Vaccines to Volatility: Financial Market Drivers as COVID-19 Evolved", CSEAR Virtual Conference (2021)

Sheehan, B. & Martin, M.: Contributed to RIAI Design for Manufacture and Assembly. Design for Manufacture and Assembly (DfMA) Report. October 2022.

Furxhi Irini: Data FAIRification Award: Nano-Week and NanoCommons Final Conference, June 20-24, Cyprus. 2022

Furxhi Irini: Best Oral Presentation: Data Shepherding in ASINA. The Initiation. Nano-Week and NanoCommons Final Conference, June 20-24, Cyprus. 2022

Cremer, F: Cyber Risk Management Research (2022), Annual board meeting of the insurance institute, TH Köln

Cremer. F: Guest Blog: Cyber risk and cybersecurity: A systematic review of data availability. Cyber Economics (Web), 12/5/2022

Owens, E. Development of Accounting, Finance and Governance Review back issues online (2003-2021)

Shannon, D. Guest on Data Skeptic podcast episode. Episode released December 2021

Leandro Masello: Press release Lero Fitting Advanced Driving Assistance Systems to all cars could prevent 24% of British road crashes. Incl. Science Foundation Ireland (Web), 29/11/2022, https://www.sfi.ie/research-news/news/advanced-driving-systems/

Masello, L. "How does driving context influence speeding: An eXplainable AI approach". Poster presented at the 2022 BMW summer school in July 2022.

Cyber risk and cybersecurity: a systematic review of data availability

Cremer, F., Sheehan, B., Fortmann, M., Kia, A.N., Mullins, M., Murphy, F. and Materne, S.

Abstract:
Cybercrime is estimated to have cost the global economy just under USD 1 trillion in 2020, indicating an increase of more than 50% since 2018. With the average cyber insurance claim rising from USD 145,000 in 2019 to USD 359,000 in 2020, there is a growing necessity for better cyber information sources, standardised databases, mandatory reporting and public awareness. This research analyses the extant academic and industry literature on cybersecurity and cyber risk management with a particular focus on data availability. From a preliminary search resulting in 5219 cyber peer-reviewed studies, the application of the systematic methodology resulted in 79 unique datasets. We posit that the lack of available data on cyber risk poses a serious problem for stakeholders seeking to tackle this issue. In particular, we identify a lacuna in open databases that undermine collective endeavours to better manage this set of risks. The resulting data evaluation and categorisation will support cybersecurity researchers and the insurance industry in their efforts to comprehend, metricise and manage cyber risks.

Citation: Cremer, F., Sheehan, B., Fortmann, M., Kia, A.N., Mullins, M., Murphy, F. and Materne, S., 2022. Cyber risk and cybersecurity: a systematic review of data availability. *The Geneva Papers on Risk and Insurance-Issues and Practice*, pp.1-39.

Diversification and Solvency II: the capital effect of portfolio swaps on non-life insurers

Sheehan, B., Humberg, C., Shannon, D., Fortmann, M. and Materne, S.

Abstract:
Diversification plays a pivotal role under the risk-based capital regime of Solvency II. The new rules reward large and well-diversified insurance companies with relatively low capital requirements compared to those of small and specialised nature. To enhance diversification, insurance companies can adjust their strategy by engaging in mergers and acquisitions or new market entries. Alternatively, insurers can accept higher Solvency II capital requirements, displaying a competitive disadvantage and impeding future growth. This research proposes a Solvency II portfolio swap as a new diversification solution that allows small and specialised insurance companies to improve their diversification, and thus, mitigate their diversification disadvantage. The effect of such swaps is demonstrated through the use of two hypothetical insurance companies by swapping 20% of their portfolio over four different scenarios. The swap allowed for a 6% reduction in the Solvency Capital Requirement (SCR) and a maximum increase of the SCR coverage ratio of 17%. With Solvency II posited to stimulate further mergers and acquisitions within the European insurance market, this paper offers an alternative method for insurers to diversify their portfolio. Furthermore, it is suggested that the proposed alternative risk transfer method may improve insurance market competition within the EU by facilitating small and specialised insurers' competitiveness.

Citation: Sheehan, B., Humberg, C., Shannon, D., Fortmann, M. and Materne, S., 2022. Diversification and Solvency II: the capital effect of portfolio swaps on non-life insurers. The Geneva Papers on Risk and Insurance-Issues and Practice, pp.1-34.

Creating ethics guidelines for artificial intelligence and big data analytics customers: The case of the consumer European insurance market

Mullins, M., Holland, C.P. and Cunneen, M.

Abstract:
Big data analytics and increasingly sophisticated forms of artificial intelligence (AI) and machine learning applications are now part of the catalog of tools and methods that inform the insurance industry's back-end and front-end operations. Insurance products and services are important to support economic and societal development. From commercial property insurance, vehicle insurance, and personal health insurance, availability and access to affordable insurance products are key to society and citizens. That said, insurance products and services can only be accessible if a sustainable balance is achieved between the pricing of policies, operational costs, and claims. AI and machine learning have already proved valuable to the insurance industry in sustaining this balance. However, with the increased use of AI and machine learning, new risks and ethical questions are introduced to the insurance pipeline. Accordingly, there is a need to investigate the ethical contexts and questions of data use in insurance innovation and highlight the emerging tensions and concerns where possible. The paper combines the expertise of insurance experts and an AI ethics expert to assess and better understand some of the ethical ground relating to the tensions concerning how the insurance industry uses big data analytics, AI, and machine learning methods to sustain its commercial operations.

From traditional to autonomous vehicles: a systematic review of data availability

Masello, L., Sheehan, B., Murphy, F., Castignani, G., McDonnell, K. and Ryan, C.

Abstract:
The increasing accessibility of mobility datasets has enabled research in green mobility, road safety, vehicular automation, and transportation planning and optimization. Many stakeholders have leveraged vehicular datasets to study conventional driving characteristics and self-driving tasks. Notably, many of these datasets have been made publicly available, fostering collaboration, scientific comparability, and replication. As these datasets encompass several study domains and contain distinctive characteristics, selecting the appropriate dataset to investigate driving aspects might be challenging. To the best of the authors' knowledge, this is the first paper that performs a systematic review of a substantial number of vehicular datasets covering various automation levels. In total, 103 datasets have been reviewed, 35 of which focused on naturalistic driving, and 68 on self-driving tasks. The paper gives researchers the possibility of analyzing the datasets' principal characteristics and their study domains. Most naturalistic datasets have been centered on road safety and driver behavior, although transportation planning and eco-driving have also been studied. Furthermore, datasets for autonomous driving have been analyzed according to their target self-driving tasks. A particular focus has been placed on data-driven risk assessment for the vehicular ecosystem. It is observed that there exists a lack of relevant publicly available datasets that challenge the creation of new risk assessment models for semi- and fully automated vehicles. Therefore, this paper conducts a gap analysis to identify possible approaches using existing datasets and, additionally, a set of relevant vehicular data fields that could be incorporated in future data collection campaigns to address the challenge.

Amending the heston stochastic volatility model to forecast local motor vehicle crash rates: A case study of Washington, DC.

Shannon, D. and Fountas, G.

Abstract:
Modelling crash rates in an urban area requires a swathe of data regarding historical and prevailing traffic volumes and crash events and characteristics. Provided that the traffic volume of urban networks is largely defined by typical work and school commute patterns, crash rates can be determined with a reasonable degree of accuracy. However, this process becomes more complicated for an area that is frequently subject to peaks and troughs in traffic volume and crash events owing to exogenous events – for example, extreme weather – rather than typical commute patterns. One such area that is particularly exposed to exogenous events is Washington, D.C., which has seen a large rise in crash events between 2009 and 2020. In this study, we adopt a forecasting model that embeds heterogeneity and temporal instability in its estimates in order to improve upon forecasting models currently used in transportation and road safety research. Specifically, we introduce a stochastic volatility model that aims to capture the nuances associated with crash rates in Washington, D.C. We determine that this model can outperform conventional forecasting models, but it does not perform well in light of the unique travel patterns exhibited throughout the COVID-19 pandemic. Nevertheless, its adaptability to the idiosyncrasies of Washington, D.C. crash rates demonstrates its ability to accurately simulate localised crash rates processes, which can be further adapted in public policy contexts to form road safety targets.

Ethical AI for Automated Bus Lane Enforcement

Lannon, C., Nelson, J. and Cunneen, M.

Abstract:
There is an explosion of camera surveillance in our cities today. As a result, the risks of privacy infringement and erosion are growing, as is the need for ethical solutions to minimise the risks. This research aims to frame the challenges and ethics of using data surveillance technologies in a qualitative social context. A use case is presented which examines the ethical data required to automatically enforce bus lanes using camera surveillance and proposes ways of minimising the risks of privacy infringement and erosion in that scenario. What we seek to illustrate is that there is a challenge in using technologies in positive, socially responsible ways. To do that, we have to better understand the use case and not just the present, but also the downstream risks, and the downstream ethical questions. There is a gap in the literature in this aspect as well as a gap in the actual thinking of researchers in terms of understanding and responding to it. A literature review and detailed risk analysis of automated bus lane enforcement is conducted. Based on this, an ethical design framework is proposed and applied to the use case. Several potential solutions are created and described. The final chosen solution may also be broadly applicable to other use cases. We show how it is possible to provide an ethical AI solution for detecting infringements that incorporates privacy-by-design principles, while being fair to potential transgressors. By introducing positive, pragmatic and adaptable methods to support and uphold privacy, we support access to innovation that can help us mitigate current emerging risks.

Health and environmental safety of nanomaterials: O Data, Where Art Thou?

Furxhi, I.

Abstract:

Nanotechnology keeps drawing attention due to the great tunable properties of nanomaterials in comparison to their bulk conventional materials. The growth of nanotechnology in combination with the digitization era has led to an increased need of safety related data. In addition to safety, new data-driven paradigms on safe and sustainable by design materials are stressing the necessity of data even more. Data is a fundamental asset to the scientific community in studying and analysing the entire life-cycle of nanomaterials. Unfortunately, data exist in a scattered fashion, in different sources and formats. To our knowledge, there is no study focusing on aspects of actual data-structure knowledge that exists in literature and databases. The purpose of this review research is to transparently and comprehensively, display to the nanoscience community the datasets readily available for machine learning purposes making it convenient and more efficient for the next users such as modellers or data curators to retrieve information. We systematically recorded the features and descriptors available in the datasets and provide synopsised information on their ranges, forms and metrics in the supplementary material.

The risk perception of nanotechnology: evidence from twitter

Murphy, F., Alavi, A., Mullins, M., Furxhi, I., Kia, A. and Kingston, M.

Abstract:

Nanotechnology governance, particularly in relation to human and environmental concerns, remains a contested domain. In recent years, the creation of both a risk governance framework and council has been actively pursued. Part of the function of a governance framework is the communication to external stakeholders. Existing descriptions on the public perceptions of nanotechnology are generally positive with the attendant economic and societal benefits being forefront in that thinking. Debates on nanomaterials' risk tend to be dominated by expert groupings while the general public is largely unaware of the potential hazards. Communicating via social media has become an integral part of everyday life facilitating public connectedness around specific topics that was not feasible in the pre-digital age. When civilian passive stakeholders become active their frustration can quickly coalesce into a campaign of resistance, and once an issue starts to develop into a campaign it is difficult to ease the momentum. Simmering discussions with moderate local attention can gain international exposure resulting in pressure and it can, in some cases, quickly precipitate legislative action and/or economic consequences. This paper highlights the potential of such a runaway, twitterstorm. We conducted a sentiment analysis of tweets since 2006 focusing on silver, titanium and carbon-based nanomaterials. We further examined the sentiment expressed following the decision by the European Food Safety Authority (EFSA) to phase out the food additive titanium dioxide (E 171). Our analysis shows an engaged, attentive public, alert to announcements from industry and regulatory bodies. We demonstrate that risk governance frameworks, particularly the communication aspect of those structures must include a social media blueprint to counter misinformation and alleviate the potential impact of a social media induced regulatory and economic reaction.

ASINA Project: Towards a Methodological Data-Driven Sustainable and Safe-by-Design Approach for the Development of Nanomaterials

Furxhi, I., Perucca, M., Blosi, M., de Ipiña, J.L., Oliveira, J., Murphy, F. and Costa, A.L.

Abstract:
The novel chemical strategy for sustainability calls for a Sustainable and Safe-by-Design (SSbD) holistic approach to achieve protection of public health and the environment, industrial relevance, societal empowerment, and regulatory preparedness. Based on it, the ASINA project expands a data-driven Management Methodology (ASINA-SMM) capturing quality, safety, and sustainability criteria across the Nano-Enabled Products' (NEPs) life cycle. We base the development of this methodology through value chains of highly representative classes of NEPs in the market, namely, (i) self-cleaning/air-purifying/antimicrobial coatings and (ii) nano-structured capsules delivering active phases in cosmetics. These NEPs improve environmental quality and human health/wellness and have innovative competence to industrial sectors such as healthcare, textiles, cosmetics, and medical devices. The purpose of this article is to visually exhibit and explain the ASINA approach, which allows identifying, combining, and addressing the following pillars: environmental impact, techno-economic performance, functionality, and human and environmental safety when developing novel NEPs, at an early stage. A metamodel supports the above by utilizing quality data collected throughout the NEPs' life cycle, for maximization of functionality (to meet stakeholders needs) and nano-safety (regulatory obligations) and for the minimization of costs (to meet business requirements) and environmental impacts (to achieve sustainability). Furthermore, ASINA explores digitalization opportunities (digital twins) to speed the nano-industry translation into automatic progress towards economic, social, environmental, and governance sustainability.

Precaution as a Risk in Data Gaps and Sustainable Nanotechnology Decision Support Systems: a Case Study of Nano-Enabled Textiles Production

Furxhi, I., Murphy, F., Poland, C.A., Cunneen, M. and Mullins, M.

Abstract:
In light of the potential long-term societal and economic benefits of novel nano-enabled products, there is an evident need for research and development to focus on closing the gap in nano-materials (NMs) safety. Concurrent reflection on the impact of decision-making tools, which may lack the capability to assist sophisticated judgements around the risks and benefits of the introduction of novel products (or pilot production lines), is essential. This paper addresses the potential for extant decision support tools to default to a precautionary principle position in the face of uncertainty. A more utilitarian-based approach could be facilitated by adding simple methods to formulate realistic hypotheses, which would assist non-specialists to make more nuanced decisions in terms of managing the risks of introducing new NMs. A decision support analytical framework is applied to identify the potential risks and benefits of novel nano-enabled products such as textiles with in-built enhanced antimicrobial activity for the prevention of nosocomial infections produced by spray or sonochemical coating possesses. While the results demonstrate valuable societal and environmental benefits compared to conventional products, due to uncertainty regarding the possible hazard to humans, sizable risks were identified in some cases due to the precautionary principle.

A machine learning tool to predict the antibacterial capacity of nanoparticles

Mirzaei, M., Furxhi, I., Murphy, F. and Mullins, M.

Abstract:
The emergence and rapid spread of multidrug-resistant bacteria strains are a public health concern. This emergence is caused by the overuse and misuse of antibiotics leading to the evolution of antibiotic-resistant strains. Nanoparticles (NPs) are objects with all three external dimensions in the nanoscale that varies from 1 to 100 nm. Research on NPs with enhanced antimicrobial activity as alternatives to antibiotics has grown due to the increased incidence of nosocomial and community acquired infections caused by pathogens. Machine learning (ML) tools have been used in the field of nanoinformatics with promising results. As a consequence of evident achievements on a wide range of predictive tasks, ML techniques are attracting significant interest across a variety of stakeholders. In this article, we present an ML tool that successfully predicts the antibacterial capacity of NPs while the model's validation demonstrates encouraging results ($R2 = 0.78$). The data were compiled after a literature review of 60 articles and consist of key physico-chemical (p-chem) properties and experimental conditions (exposure variables and bacterial clustering) from in vitro studies. Following data homogenization and pre-processing, we trained various regression algorithms and we validated them using diverse performance metrics. Finally, an important attribute evaluation, which ranks the attributes that are most important in predicting the outcome, was performed. The attribute importance revealed that NP core size, the exposure dose, and the species of bacterium are key variables in predicting the antibacterial effect of NPs. This tool assists various stakeholders and scientists in predicting the antibacterial effects of NPs based on their p-chem properties and diverse exposure settings. This concept also aids the safe-by-design paradigm by incorporating functionality tools.

A Supervised Machine-Learning Prediction of Textile's Antimicrobial Capacity Coated with Nanomaterials

Mirzaei, M., Furxhi, I., Murphy, F. and Mullins, M.

Abstract:
Textile materials, due to their large surface area and moisture retention capacity, allow the growth of microorganisms, causing undesired effects on the textile and on the end-users. The textile industry employs nanomaterials (NMs)/composites and nanofibers to enhance textile features such as water/dirt-repellent, conductivity, antistatic properties, and enhanced antimicrobial properties. As a result, textiles with antimicrobial properties are an area of interest to both manufacturers and researchers. In this study, we present novel regression models that predict the antimicrobial activity of nano-textiles after several washes. Data were compiled following a literature review, and variables related to the final product, such as the experimental conditions of nano-coating (finishing technologies) and the type of fabric, the physicochemical (p-chem) properties of NMs, and exposure variables, were extracted manually. The random forest model successfully predicted the antimicrobial activity with encouraging results of up to 70% coefficient of determination. Attribute importance analysis revealed that the type of NM, shape, and method of application are the primary features affecting the antimicrobial capacity prediction. This tool helps scientists to predict the antimicrobial activity of nano-textiles based on p-chem properties and experimental conditions. In addition, the tool can be a helpful part of a wider framework, such as the prediction of products functionality embedded into a safe by design paradigm, where products' toxicity is minimized, and functionality is maximized.

On the road safety benefits of advanced driver assistance systems in different driving context

Masello, L., Castignani, G., Sheehan, B., Murphy, F. and McDonnell, K.

Abstract:
Advanced Driver Assistance Systems (ADAS) have introduced several benefits in the vehicular industry, and their proliferation presents potential opportunities to decrease road accidents. The reasons are mainly attributed to the enhanced perception of the driving environment and reduced human errors. However, as environmental and infrastructural conditions influence the performance of ADAS, the estimation of accident reductions varies across geographical regions. This study presents an interdisciplinary methodology that integrates the literature on advanced driving technologies and road safety to quantify the expected impact of ADAS on accident reduction across combinations of road types, lighting, and weather conditions. The paper investigates the safety effectiveness of ADAS and the distribution of frequency and severity of road accidents across 18 driving contexts and eight accident types. Using road safety reports from the United Kingdom (UK), it is found that a high concentration of accidents (77%) occurs within a small subset of contextual conditions (4 out of 18) and that the most severe accidents happen in dark conditions on rural roads or motorways. The results of the safety effectiveness analysis show that a full deployment of the six most common ADAS would reduce the road accident frequency in the UK by 23.8%, representing an annual decrease of 18,925 accidents. The results also show that the most frequent accident contexts, urban-clear-daylight and rural-clear-daylight, can be reduced by 29%, avoiding 7,020 and 3,472 accidents, respectively. Automatic Emergency Braking (AEB) is the most impactful technology, reducing three out of the four most frequent accident categories – intersection (by 28%), rear-end (by 27.7%), and pedestrian accidents (by 28.4%). This study helps prioritise resources in ADAS research and development focusing on the most relevant contexts to reduce the frequency and severity of road accidents. Furthermore, the identified contextual accident hotspots can assist road safety stakeholders in risk mitigation programs.

Citation: Masello, L., Castignani, G., Sheehan, B., Murphy, F. and McDonnell, K., 2022. On the road safety benefits of advanced driver assistance systems in different driving contexts. Transportation research interdisciplinary perspectives, 15, p.100670.

Quantifying Emission Factors and Setting Conditions of Use According to ECHA Chapter R. 14 for a Spray Process Designed for Nanocoatings—A Case Study

Koivisto, A.J., Del Secco, B., Trabucco, S., Nicosia, A., Ravegnani, F., Altin, M., Cabellos, J., Furxhi, I., Blosi, M., Costa, A. and Lopez de Ipiña, J.

Abstract:
Spray coatings' emissions impact to the environmental and occupational exposure were studied in a pilot-plant. Concentrations were measured inside the spray chamber and at the work room in Near-Field (NF) and Far-Field (FF) and mass flows were analyzed using a mechanistic model. The coating was performed in a ventilated chamber by spraying titanium dioxide doped with nitrogen (TiO_2N) and silver capped by hydroxyethylcellulose (Ag-HEC) nanoparticles (NPs). Process emission rates to workplace, air, and outdoor air were characterized according to process parameters, which were used to assess emission factors. Full-scale production exposure potential was estimated under reasonable worst-case (RWC) conditions. The measured TiO_2-N and Ag-HEC concentrations were 40.9 TiO_2-µg/m3 and 0.4 Ag-µg/m3 at NF (total fraction). Under simulated RWC conditions with precautionary emission rate estimates, the worker's 95th percentile 8-h exposure was ≤171 TiO_2 and ≤1.9 Ag-µg/m3 (total fraction). Environmental emissions via local ventilation (LEV) exhaust were ca. 35 and 140 mg-NP/g-NP, for TiO_2-N and Ag-HEC, respectively. Under current situation, the exposure was adequately controlled. However, under full scale production with continuous process workers exposure should be evaluated with personal sampling if recommended occupational exposure levels for nanosized TiO_2 and Ag are followed for risk management.

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Explainable Artificial Intelligence (XAI) in Insurance

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Abstract:
Explainable Artificial Intelligence (XAI) models allow for a more transparent and understandable relationship between humans and machines. The insurance industry represents a fundamental opportunity to demonstrate the potential of XAI, with the industry's vast stores of sensitive data on policyholders and centrality in societal progress and innovation. This paper analyses current Artificial Intelligence (AI) applications in insurance industry practices and insurance research to assess their degree of explainability. Using search terms representative of (X)AI applications in insurance, 419 original research articles were screened from IEEE Xplore, ACM Digital Library, Scopus, Web of Science and Business Source Complete and EconLit. The resulting 103 articles (between the years 2000–2021) representing the current state-of-the-art of XAI in insurance literature are analysed and classified, highlighting the prevalence of XAI methods at the various stages of the insurance value chain. The study finds that XAI methods are particularly prevalent in claims management, underwriting and actuarial pricing practices. Simplification methods, called knowledge distillation and rule extraction, are identified as the primary XAI technique used within the insurance value chain. This is important as the combination of large models to create a smaller, more manageable model with distinct association rules aids in building XAI models which are regularly understandable. XAI is an important evolution of AI to ensure trust, transparency and moral values are embedded within the system's ecosystem. The assessment of these XAI foci in the context of the insurance industry proves a worthwhile exploration into the unique advantages of XAI, highlighting to industry professionals, regulators and XAI developers where particular focus should be directed in the further development of XAI. This is the first study to analyse XAI's current applications within the insurance industry, while simultaneously contributing to the interdisciplinary understanding of applied XAI. Advancing the literature on adequate XAI definitions, the authors propose an adapted definition of XAI informed by the systematic review of XAI literature in insurance

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