A Novel Natural Language Processing Approach to Support Decision Making for Adapting Critical Infrastructure to Climate Change

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Background/Objectives. Climate change is driving significant shifts in average and extreme climate conditions and weather events. From an infrastructure perspective, shifts in operating environments and increasing frequency and severity of natural hazards due to climate change challenge continuity of infrastructure operations. To ensure continued operations, owners and operators of critical infrastructure (e.g., water and electric power systems) across the nation need to adapt their infrastructure to changing climatological conditions. Given this significant challenge, owners and operators of critical infrastructure, as well as other governmental and non-governmental stakeholders whose communities rely on this infrastructure, need decision support tools and methodologies that can inform adaptation strategies and enable effective risk management. Scientific and engineering literature on climate change hazards, impacts on critical infrastructure, and climate adaptation contain an enormous extent of actionable information. However, the sheer volume of existing literature and the rate of new publications exceeds the ability of an individual or even teams of decision makers to review. Without an effective way to ingest this information, decision makers are limited in their ability to identify promising emerging technologies and best practices, increasing the likelihood of sub-optimal decision making.

Approach/Activities. To address this need, our team of researchers at Argonne National Laboratory is developing the Community and Infrastructure Adaptation to Climate Change (CIACC) tool. The tool leverages several artificial intelligence (AI) techniques including advanced natural language processing (NLP) methods to analyze large volumes of climate-change-related scientific literature. We developed an NLP workflow to generate categorical labels for a large corpus of climate research without requiring manual annotation; perform category-based topic modeling; find relevant documents within the corpus given a search query; summarize text from a large number of documents; and respond to specific analyst questions in order to support decision makers in climate adaptation efforts.

Results/Lessons Learned. The CIACC tool synthesizes large volumes of diverse literature to identify cutting-edge and actionable information on climate hazards, risks to critical infrastructure, and climate adaptation best practices, ultimately helping decision makers better safeguard their systems and communities. A key contribution of this work is the implementation of weak supervised learning which eliminates the burden of manual review and annotation of thousands of documents typically required for machine learning models. This novel approach enabled the team to rapidly extract tailored research corpora focused on critical infrastructure corpus and climate change using an existing open-source corpus. Our work to date has (i) quantified correlations across climate change hazards and trends, (ii) explored the intersection of climate change, critical infrastructure, and national critical functions, (iii) captured interdependencies across critical infrastructure sectors and between national critical functions, and (iv) illuminated key topics and concepts underlying climate change impacts on critical infrastructure sectors and national critical functions, as well as corresponding climate adaptation strategies.