Computational and Data-Driven Approaches to Estimate Missing Data in Life Cycle Assessment for Environmental Footprint Analysis

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Abstract
Life cycle assessment (LCA) has become a mainstream method in evaluating environmental impacts of product systems for environmental policy making. Through life cycle thinking, LCA measures the environmental impacts associated with each phase of a product’s life cycle from raw material acquisition to end-of-life disposal, or commonly known as environment footprint. One of the challenges facing LCA research and practice is missing data. Due to lack of primary data or high cost of collecting primary data, LCA studies often need to make unrealistic assumptions, leading to inaccurate results. To address this challenge, we have developed new computational methods using data science tools to estimate missing data in LCA solely relying on limited known data. The first example is to estimate missing unit process data using a similarity-based approach. The intuition is that similar processes in a unit process network tend to have similar material/energy inputs and waste/emission outputs. We use the ecoinvent 3.1 unit process datasets to test our method. The results show that missing data can be accurately estimated when less than 5% data are missing in one process. The estimation performance decreases as the percentage of missing data increases. The second example is to use artificial neural network models to estimate ecotoxicity characterization factors for chemicals. These studies provide a new direction to obtain data for LCA and demonstrates a promising potential of using data science approaches for LCA data compilation.

About the Speaker
Dr. Ming Xu is an Associate Professor and Director of China Programs in School for Environment and Sustainability and an Associate Professor in Department of Civil and Environmental Engineering at the University of Michigan, Ann Arbor. He earned his BS and MS from Tsinghua University, China, and PhD from Arizona State University, all in environmental engineering. His research focuses on environmental footprint analysis and environmental impacts of emerging technologies. At the University of Michigan, he co-directs the Graduate Certificate Program in Industrial Ecology. He was awarded the Robert A. Laudise Medal from International Society for Industrial Ecology for “outstanding achievement in industrial ecology by a researcher under the age of 36” in 2015. He received the US National Science Foundation Faculty Early Career Development (CAREER) Award in 2016. Currently he serves as the President of Chinese Society for Industrial Ecology and Editor-in-Chief of the journal Resources, Conservation & Recycling. He was elected to Chair the 2022 Gordon Research Conference on Industrial Ecology.