Derek Anderson, IEEE Senior Member (2023-2025)

Electrical Engineering and Computer Science department
The University of Missouri-Columbia
Homepage: http://www.derektanderson.com/cv.pdf.
e-mail: andersondt@missouri.edu

Topic 1: What is a Good Information Fusion Explanation?

Abstract: Our modern era of artificial intelligence is deeply rooted in data-driven learning. While this has given rise to astonishing leaps in domain specific applications, e.g., deep learning for computer vision, we are left wondering what was learned and what lead to a specific output (decision). In this talk, I will focus on data-driven information fusion. Recently, we established several data and model centric explainable indices for the fuzzy measure and integral. These techniques range from information theoretic indices to visual, statistical, local, and linguistic explanations. While this talk introduces a few measures, it does the such in the context of "what is a good explanation?" There are many explanations that can be generated. Which explanations are important? I will advocate that one way to answer this question is actionable XAI. The idea is to connect machine explanations to user or system actions/activities. A visual and interactive XAI fusion report will be discussed and demonstrated in the form of a case study.

Topic 2: Generalized Fuzzy Extension Principle and Its Application to Information Fusion

Abstract: One of the most fundamental ideas in fuzzy set theory, proposed originally by Lotfi Zadeh, is the fuzzy extension principle. However, while mathematically sound, there are several real-world scenarios in which Zadeh's original definition semantically fails to match human expectation. In this talk, I will discuss our recent generalized extension principle (GEP). The GEP eliminates many semantic weaknesses, and it provides flexibility and control over membership value assignment. I will also discuss a computationally efficient point-based fuzzy set representation and GEP algorithm. Last, this talk will show to use the GEP to generate existing and new extensions of the fuzzy integral. A combination of synthetic and a case study from skeletal age-at-death-estimation in forensic anthropology is provided.

Topic 3: Explainable Fuzzy Fusion Networks

Abstract: Data/information fusion is an essential part of numerous engineering solutions and biological functions, e.g., human cognition. Fusion occurs at many levels, ranging from the low-level combination of signals to the high-level aggregation of heterogeneous decision-making processes. While the last decade has witnessed an explosion of research in deep learning, fusion in the context of neural networks has not observed the same revolution. Specifically, most neural fusion approaches are ad hoc, they are not well understood, they are distributed versus localized, and/or explainability is low (if present at all). In this talk, I will demonstrate that the fuzzy Choquet integral (ChI), a powerful nonlinear aggregation function, can be represented as a multi-layer network called ChIMP. This talk also covers our improved ChIMP (iChIMP) and a novel gradient

descent optimization that mitigates fuzzy measure constraints. These concepts are demonstrated via a controlled synthetic example and a real-world application based on the fusion of a set of heterogeneous architecture deep learning models for detection in remote sensing. I will demonstrate that the proposed ideas lead to an improvement in classification accuracy and our previously established XAI indices shed light on the quality of our data, model, and its decisions.

Topic 4: Game Engines for Training and Understanding Computational Intelligence Algorithms (this topic might be suitable for beginners/ undergraduate students/industries)

Abstract: Many modern computational intelligence (CI) algorithms are data driven. However, where does the data come from? What biases are present in the data, algorithms, and models? Where do our methods work/not work? Where does ground truth come from and how is it used to train or evaluate a CIsolution? To date, in applications like computer vision, ground truth is manually collected. This process is expensive (time and money), error prone (inter/intra observer error), and it is a scale bottleneck. This has led many big companies like Google, Microsoft, Apple, Tesla, and others to invest millions and billions in simulation for training and evaluating artificial intelligence solutions. My research team is exploring how to leverage the recent maturation and convergence of photo-realistic game engines, open-source codes, computing resources, and high-quality assets (models, materials, and environments) to procedurally generate large and accurately truthed data sets. In this talk, I will discuss our framework and three case studies will be provided. Case study one is a workflow for training neural netsto perform object detection and monocular vision that transfer to the real world. Case two is focused on context-based fuzzy information fusion. Case three is visual and linguistic explainable AI (XAI) applied to a deep neural network. The goal of this talk is to show and teach how game engines can be used to rapid prototype CI ideas, help us better understand complex behaviors in complex CI systems, and scale CI solutions to big problem domains.