CREST MECIS – Spring 2023 Webinar Series – 5/11/2023

Presentation 1: **Dr. Vagelis Papalexakis and Dr. Jia Chen, University of California-Riverside (UCR)**

Title: Joint Tensor Alignment and Coupled Factorization

Abstract:

Multimodal datasets represented as tensors oftentimes share some of their modes. However, even though there may exist a one-to-one (or perhaps partial) correspondence between the coupled modes, such correspondence/alignment may not be given, especially when integrating datasets from disparate sources. This is a very important problem, broadly termed as entity alignment or matching, and subsets of the problem such as graph matching have been extremely popular in recent years. To solve this problem, current work computes the alignment based on existing embeddings of the data. This can be problematic if our end goal is the joint analysis of the two datasets into the same latent factor space: the embeddings computed separately per dataset may yield a suboptimal alignment, and if such an alignment is used to subsequently compute the joint latent factors, the computation will similarly be plagued by compounding errors incurred by the imperfect alignment. In this work, we are the first to define and solve the problem of joint tensor alignment and factorization into a shared latent space. By posing this as a unified problem and solving for both tasks simultaneously, we observe that both alignment and factorization tasks benefit each other resulting in superior performance compared to two-stage approaches. We extensively evaluate our proposed method TENALIGN and conduct a thorough sensitivity and ablation analysis. We demonstrate that TENALIGN significantly outperforms baseline approaches where embedding and matching happen separately.

Presentation 2: **Dr. Fatemeh Nazari and Dr. Mohamadhossein Noruzoliaee, University of Texas Rio Grande Valley (UTRGV)**

Title: Data-Driven Multi-Horizon Prediction of Ridesharing Spatiotemporal Demand Pattern

Abstract:

Technological advances in providing near ubiquitous mobility in the past decade have led to introducing on-demand shared mobility, in particular, ridesharing services. The accurate prediction of rider demand over space and time is a crucial input to improving the ridesharing system efficiency, for instance, by preemptively relocating vacant vehicles and thus slashing the rider waiting time. Focusing on the multi-horizon zone-based demand of these services, this research presents a dynamic graph convolutional neural network for both solo (e.g., Uber) and pooled (e.g., UberPool) ridesharing services. A case study of the city of Chicago is presented to demonstrate the performance of the presented model.

Presentation 3: **Sergio Martinez, Master's Student, UTRGV**

Title: Vibration-Based Machine Learning Models for Condition Monitoring of Railroad Rolling Stock

Abstract:

One of the primary causes of railroad rolling stock derailments is attributed to bearing and wheel failures. The health of a train bearing is primarily monitored at target locations through wayside and hot box detectors. This can lead to bearing failure and potential derailments at points in between them. To remedy this, the University Transportation Center for Railway Safety (UTCRS) has developed an onboard monitoring system that can continuously monitor the vibration response, which directly correlates to the health of bearings. This same data is being used to train regression-based machine learning algorithms and long-term prediction neural networks to predict bearing health. The models are intended to work in tandem with the onboard monitoring sensors as a means of two-way practical validation. The models tested were the Gradient Boosting Machine for scheduled predictions, and the Informer Neural Network architecture for long term predictions of ongoing routes. The dataset for these models comes from the expansive experimental data-set records available at the UTCRS. Ultimately, these machine learning algorithms will serve to enhance the safety of railcars and save companies money by allowing for proactive maintenance practices.

Presentation 4: **Andrea Pelayo Carvajal, Undergraduate Student, UTRGV**

Title: Erbium Doping of Lithium Tantalate Nanoparticles for Infrared Detectors

Abstract:

Lithium Tantalate ($LiTaO3$) is a multifunctional pyroelectric, piezoelectric and photoelectric material used in infrared sensors. Doping of Lithium Tantalate with Erbium ions provides excellent emissivity in both visible and near infrared wavelengths. The traditional methods of preparation require high temperature annealing and lead to large particle size due to agglomeration at calcinating temperatures. In this work, we produce nanosized Lithium Tantalate particles doped with Erbium, without altering the crystallographic structure of the material. To achieve this goal, the commercially sold micro-sized Tantalum Pentoxide is first transformed into nano-sized particles with 48% Hydrogen Fluoride in a water bath at an average temperature of 80°C for 8 hours, and is later neutralized with 30% Ammonium Hydroxide, washed with deionized water, and dried at 100°C for 12 hours. The nano-sized Tantalum Oxide is incorporated into a high-energy ball mill with a stoichiometric amount of Lithium Hydroxide and 0.5-10 mol.% Erbium Oxide. The mixture is subsequently calcinated at 650°C for 4 hours. The samples were analyzed comprehensively using thermogravimetric, structural, morphological and photoluminescence analysis methods revealing particle sizes below 100 nanometers, with strong photoluminescence at visible and near infrared wavelengths.