Applied Linear Structures for Computing - Course Justification

Several computer sciences (CS) and information technology (IT) applications, such as data analytics, machine learning, distributed computing, and artificial intelligence use fundamental notions of linear structures to facilitate the process of storing and analyzing large-scale datasets. Specifically, representing data as matrices and vectors facilitates the mathematical representation of real-world problems, and translating them into understandable equations for machines. One of the most recent instances is quantum computing.

Due to the increasing interest in data analytics, machine learning, distributed computing, and emerging computing tools that leverage notions from linear structures, it is imperative to provide computer science students with a practical understanding of linear structures, with an emphasis on the computing tools that they will frequently need during their study and future careers. In order to address these emerging needs in computing, this course proposes to address this need by providing a brief introduction to necessary concepts from linear structures/algebra during the first three weeks of the class, and then focus on the selected computing applications of these concepts that will be useful from CS and IT students. Based on the textbook entitled "Introduction to Applied Linear Algebra" and the emerging applications of linear structures in data analytics, machine learning, distributed computing, and artificial intelligence, this course provides brief introduction to basic linear structure definitions, and their corresponding operations and characteristics which is tailored towards computer science applications. The main objective of this course is to prepare CS and IT student, with little or no prior exposure to linear algebra, for deploying algorithms and methods that are highly relying on linear structures. While there are other courses, such as **MAS3105** (undergraduate level linear algebra), that mainly cover the theoretical aspects of the linear structures with an emphasis on the fundamental theorems and proofs; and **EEL3120** (introduction to linear algebra for engineers) that focuses on the materials related to linear algebra concepts as the MAS3105, as well as the applications of linear algebra in engineering, including the "*abstract concepts from linear algebra, emphasizing topics useful in engineering*" and the "*use of linear algebra to analyze resistive and dynamic electric circuits*". Computer science students need a tailored course that prepare them for dealing with the future courses such as data science courses, machine learning, and theory of computation at the School of Computing and Information Sciences. The proposed course will briefly provide an introduction to basic linear structure definitions and then focusing on computing application with the computer science perspective, from characterizing the raw data using matrices, to using linear algebra tools for data analytics, to using linear structures for distribution computing.

This undergraduate-level course will thoroughly equip students with the tools and ideas required to understand a large variety of data fitting, computing, and learning algorithms and techniques that are crucial for the development of next-generation of computing and information systems, such as quantum computing. There are many industrial, and academic positions available in high-tech companies, national labs, and universities requiring people with CS-related degrees who have solid understanding of the foundations of the AI, ML and data analytics methods. This course acts as the first step for the students who plan to understand the foundation of such methods and paves the path towards advanced senior-level and graduate-level courses. Currently, Brown University (The Matrix in Computer Science), University of Colorado Boulder (Linear Algebra with Computer Science Applications), University of Florida (Linear Algebra for Data Science), and University of Oxford (Linear Algebra for Computer Science Students) offer similar courses within the department of computer science specifically for CS/IT students.