In the Philosophies doctor and the Master's degree, the following work has been done, mentioned at the beginning of the work done in the doctoral degree.

Philosophies doctor

Research Statement: Mixed spectral and machine learning methods for solving differential equations

Introduction: I am writing to express my keen interest in the postdoctoral position at the Institute for Research in Fundamental Sciences (IPM). My passion for applying machine learning algorithms and spectral methods to solve complex problems has driven my research throughout my doctoral studies.

Research Objectives: My proposed research aims to develop novel machine-learning techniques to enhance predictive analysis in different problems. my doctoral research is a mixed spectral and machine-learning method for solving the different equations. In mathematics, physics, chemistry, economics, engineering, and other sciences, solving differential equations and finding solutions have been important topics. In recent years, researchers have gained attention to this field and many works have been done in this field. Today, there are various methods to solve such problems, and since solving the analytical solution of such problems in infinite and semi-infinite intervals is not easy, and in some cases, there is an analytical solution, the answers are not determined as functional series. Therefore, numerical methods can be used to solve such problems. In recent decades, machine learning algorithms have been successful in solving a variety of problems in different fields, which, considering this issue, has led to its use for solving differential equations and predicting future system behavior. As a result, numerical methods such as spectral methods are combined with machine learning algorithms for more efficient and rapid convergence. This thesis is focused on demonstrating how the spectral method, combined with machine learning methods, is a powerful tool for solving differential equations in the semi-infinite and infinite domains, as follows: 1) Developing a method for obtaining accurate answers that minimize errors and based on the problem's conditions. 2) It is possible to predict coefficients, even if the solution does not change, as differential equations change.

Methods and Specifics:

We used a mixture of spectral methods and machine learning algorithms to solve different differential equations with excellent results .The two algorithms we used were neural networks and support vector machines, which are summarized below.

Hermite Neural Networks

Initially, the Hermite function roots were employed as collocation points, enhancing the solution's efficiency. In this model, the activation function of the hidden layers is based on the Hermite function. However, the values of the weights can sometimes become very large, which can lead to network instability and cause the weights to overflow, resulting in NaN values. To solve this problem, orthogonal Hermite functions can be used as activation functions, as their roots prevent this issue.

Least squares support vector regression

Hermite functions are used as the orthogonal kernel of the support vector regression.
The resulting optimization problem is then reduced to a linear system in the method's collocation and Galerkin approaches.
We have used a machine learning numerical algorithm for the simulation of the elliptic differential equations on unbounded domains with two different approaches by using least squares support vector regression. The proposed approaches, the collocation, and Galerkin LS-SVR, use the Hermit orthogonal kernel as the kernel of support vectors for ordinary and fractional differential equations. These training points for the learning process are iteratively chosen in $(-Rn, Rn)$ as $Rn \rightarrow \infty$ converging to the real line with the advantage of having fast convergence with sparse structured matrices. The proposed method's main advantages are the sparsity, well-conditioned generated matrices, fast convergence, and low computational cost.

Master's degree

Research Statement: Analysis of the decision-making with the eye tracker

Research Objectives:

The purpose of this method was to analyze the correct decision-making by using two features of eye movement called fixation and saccade. We analyzed it using the Neural networks, Support vector machine, and Fuzzy.

Methods and Specifics:

First, we designed a game using Unity software, in which we implemented the concept of decision-making, and then we recorded the relevant data by connecting the eye tracker to the computer. In the end, we analyzed by using the Neural networks, Support vector machine, and Fuzzy.