

# Comprehensive Exam

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## 1 Introduction

This manuscript is an example-driven survey of broadly termed “data-enhanced dynamical systems modeling” (DataDyn). Underneath the umbrella of DataDyn, I allow any enriching of theoretical dynamical systems modeling with data. I will focus on the not exhaustive list of:

- parameterizing ODE/PDE/SDEs at a variety of levels
  - single parameter searches
  - fitting neural networks to define dynamics
  - parameterized boundary condition determination
- creating reduced-order models (ROM) via applying projection methods to data
  - linear (PCA/POD) methods
  - nonlinear autoencoder/decoder
- using differentiable programming (DP) and automatic differentiation to allow for automatic sensitivity calculation of DE solutions w.r.t. parameterizations
- applying specifically structured neural networks to improve interpretability and generalizability
- learning discretizations for PDEs

## 2 Dynamical Systems

## 3 Machine Learning

## 4 Application Examples

## 5 Conclusion & Prospectus