**Project Scope Statement**

**Project:** Automatic Calibration of ABMs Using Deep Neural Networks

**Purpose and Connection to CFA:**  
The purpose of this project is to develop a framework and accompanying R package to enable rapid, accurate calibration of agent-based models (ABMs), such as the Susceptible-Infected-Recovered (SIR) model, using convolutional neural networks (CNNs). This framework reduces the computational overhead and complexity of traditional calibration methods. The project’s outcome will be a pre-trained, scalable tool for researchers to efficiently calibrate ABMs with minimal expertise in computational epidemiology.

**Project Goals/Outcomes:**

* Develop and validate a CNN-based calibration algorithm for ABMs, focusing on epidemiological models.
* Package the framework as an R library, epiworldRcalibrate, to facilitate broader adoption.
* Demonstrate the utility of the package with a case study simulating SIR epidemic curves.
* Design user-friendly tools for parameter estimation and epidemic trajectory visualization.

**Personnel and Partners Involved:**

* Sima Najafzadehkhoei and George Vega Yon (stakeholders and project developers)

**Project Scope Description**:  
The project involves creating a deep learning-based calibration tool tailored to ABMs using CNNs. The SIR model will serve as the proof of concept, where model parameters such as infection and recovery rates are estimated using real or synthetic data. Steps include:

1. Generating synthetic datasets using the epiworldR package.
2. Training CNNs to predict model parameters from infection trajectories.
3. Developing the epiworldRcalibrate R package to streamline calibration and visualization tasks.
4. Validating the framework through comparative analyses with traditional calibration methods.

Primary Deliverables:

* An R package, epiworldRcalibrate, featuring:
  + Pre-trained CNN models for ABM calibration.
  + Functions for generating and visualizing epidemic curves.
  + Tools for parameter prediction and simulation.
* Case studies illustrating the application of the package to SIR models.
* Documentation and examples for researchers to adapt the tool for other ABMs and datasets.

Key Milestones and Timeline:

* **Complete implementation of the epiworldRcalibrate package:** Finalize all core functionalities, including parameter calibration, trajectory simulation, and visualization tools.
* **Adding pretrained models for SEIR models.**
* **Generate comprehensive** **documentation**: Create detailed user guides, examples, and reference materials to ensure the package is accessible to researchers of varying technical expertise.
* **Expand training scenarios for the CNN model:** Train the CNN using diverse simulation setups with varying population sizes, simulation durations, and parameter ranges to improve generalizability.
* **Refine the machine learning models:** Explore and integrate other ML architectures or techniques (e.g., recurrent neural networks or attention-based models) to enhance model performance. Add informative plots and visualizations to better illustrate calibration results.
* **Prepare and deliver a professional presentation**: Develop a compelling presentation to showcase the capabilities of epiworldRcalibrate, including case studies, visuals, and performance metrics.
* **Timeline:** Complete all milestones between **21 January 2025 and March 2025.**

Constraints:

* The pretrained CNN model is constrained by the fixed simulation durations (e.g., specific numbers of days). This limits flexibility for scenarios with non-standard timeframes.
* Addressing this constraint will require the development of scalable solutions to adapt the model dynamically to varying time horizons without retraining.

Assumptions:

* Synthetic datasets generated with epiworldR will adequately represent real-world dynamics.
* Deep learning models will generalize well to unseen scenarios within the target domain.

Scope Exclusions:

* Creating a perfectly accurate forecast. Our focus is on building the tool (the automated pipeline, the examples of using epiworldR, etc.), not on making an excellent forecast. Of course, we will try to make the forecast accurate, but that will come only after the tool is working properly in every other way.

Reference Documents:

* https://github.com/UofUEpiBio/epiworldRcalibrate