NUI Galway
OÉ Gaillimh

eBISS 2016

Bringing Data-Driven Intelligence to Simulation Models Using Machine Learning

Mahmoud Elbattah, Owen Molloy

National University of Ireland Galway

Introduction

The realism of simulation modeling has been a central issue. Simulation modeling is largely dominated by assumptions made with respect to the modeler's preferences, available information, or other factors, which are generally approximate and embedded in the modeling uncertainty. Therefore, all models, including simulation models, are invalid with respect to complete reality. In this study, we attempt to incorporate the simulation modeling with data-driven knowledge using machine learning. The machine learning models are used to guide the simulation model in conjunction with a simulation experiment. Specifically, predictions are made on selected system variables, which we classify as "strategic variables", defined in the next section.

The approach was experimented in the context of discharge planning for elderly patients applied to hip fracture care in Ireland. On one hand, a discrete event simulation model (DES) served as the core component. On the other hand, two machine learning models were developed in order to predict the length of stay (LOS) and discharge destination for every elderly patient generated by the simulation model.

Key Idea: Prediction vs Random Sampling

The behaviour of a simulation model is determined by the combination of:

Inputs (I) + Parameters (P) + Random Variables (R)

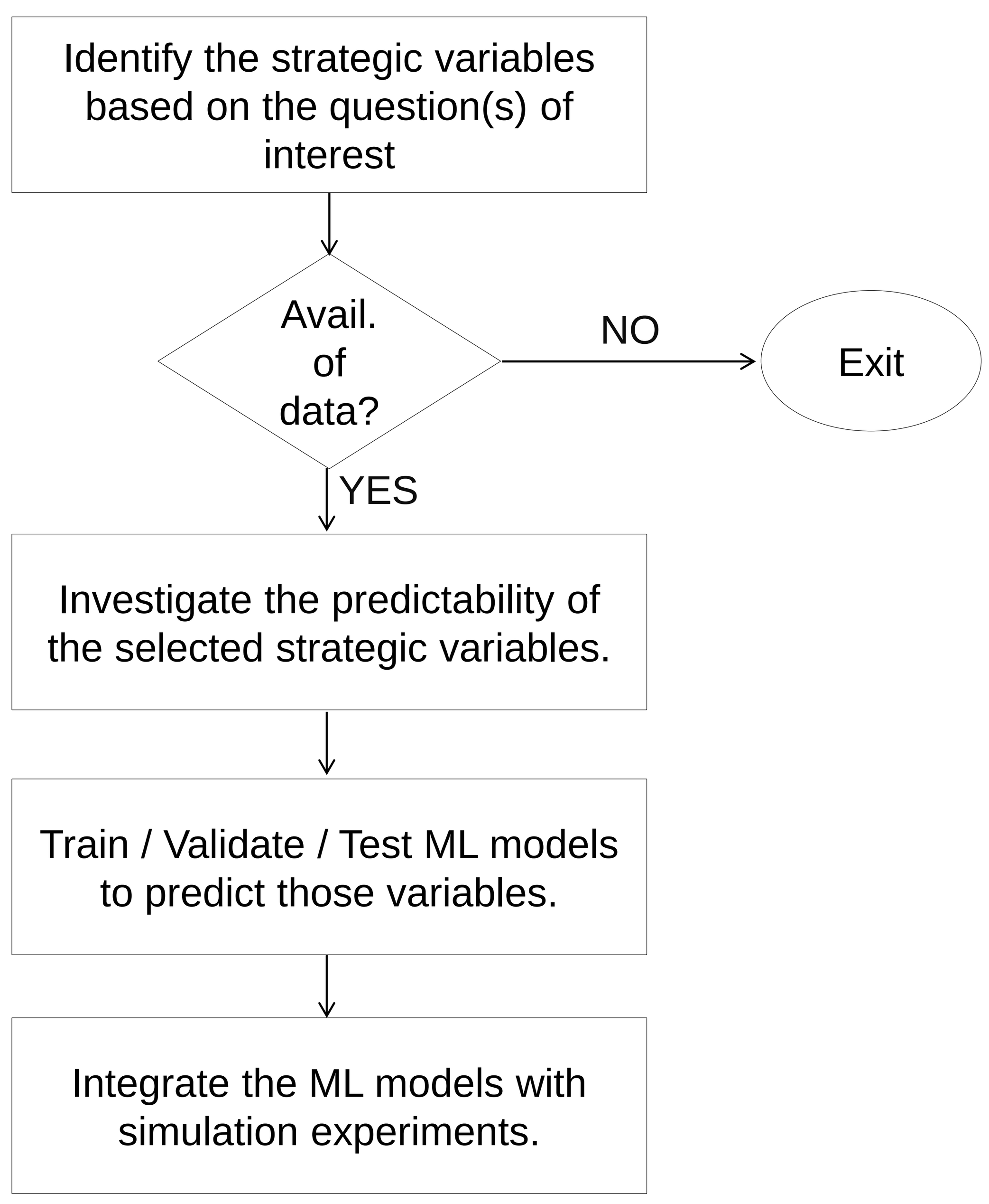
Random Variables (R)

$(X_0, X_1 \ldots X_n)$	$(Y_0, Y_1 \ldots Y_n)$
Independent Variables	Dependent Variables
Features	Labels (Strategic Variable)

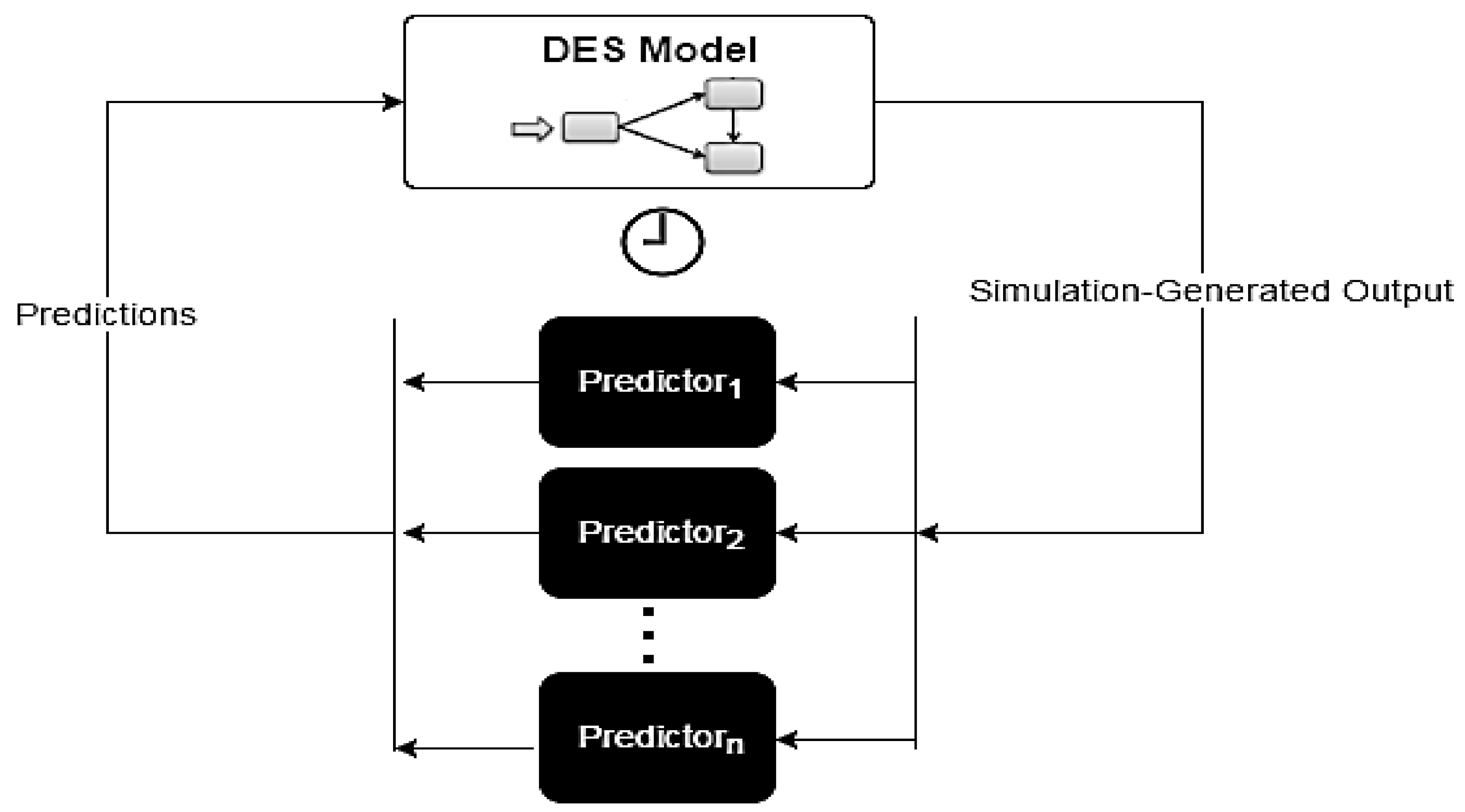
Strategic Variable:

A variable that has a significant influence on the system being modelled with respect to the question(s) of interest, whereas the variation of that variable can lead to change in policy, strategy, or decision making.

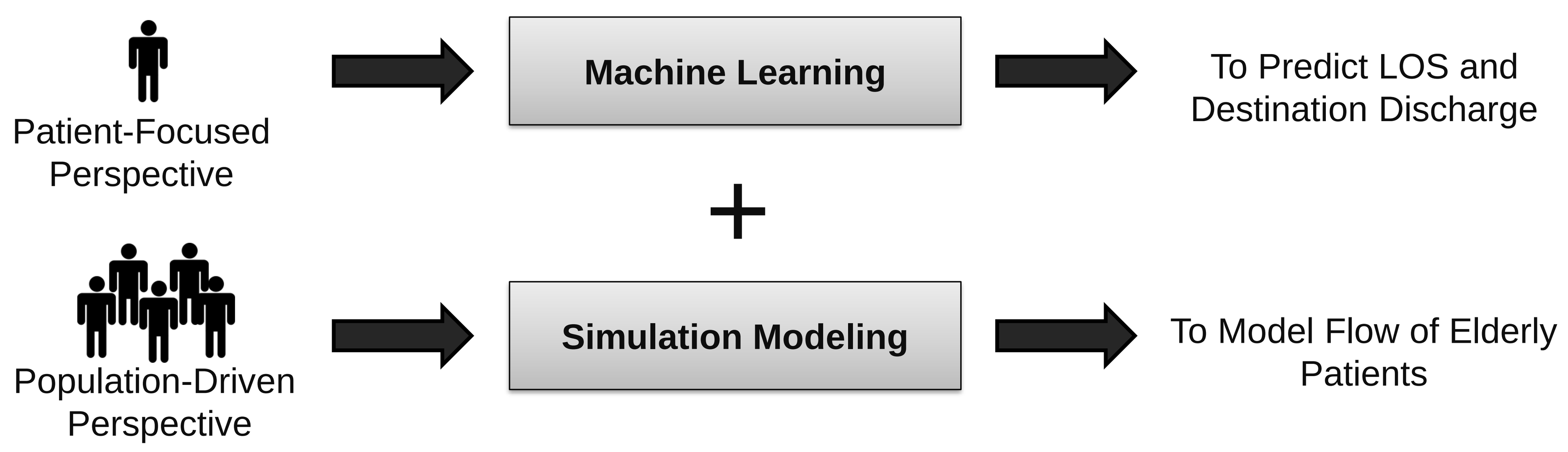
Key Idea: Prediction vs Random Sampling (cont'd)



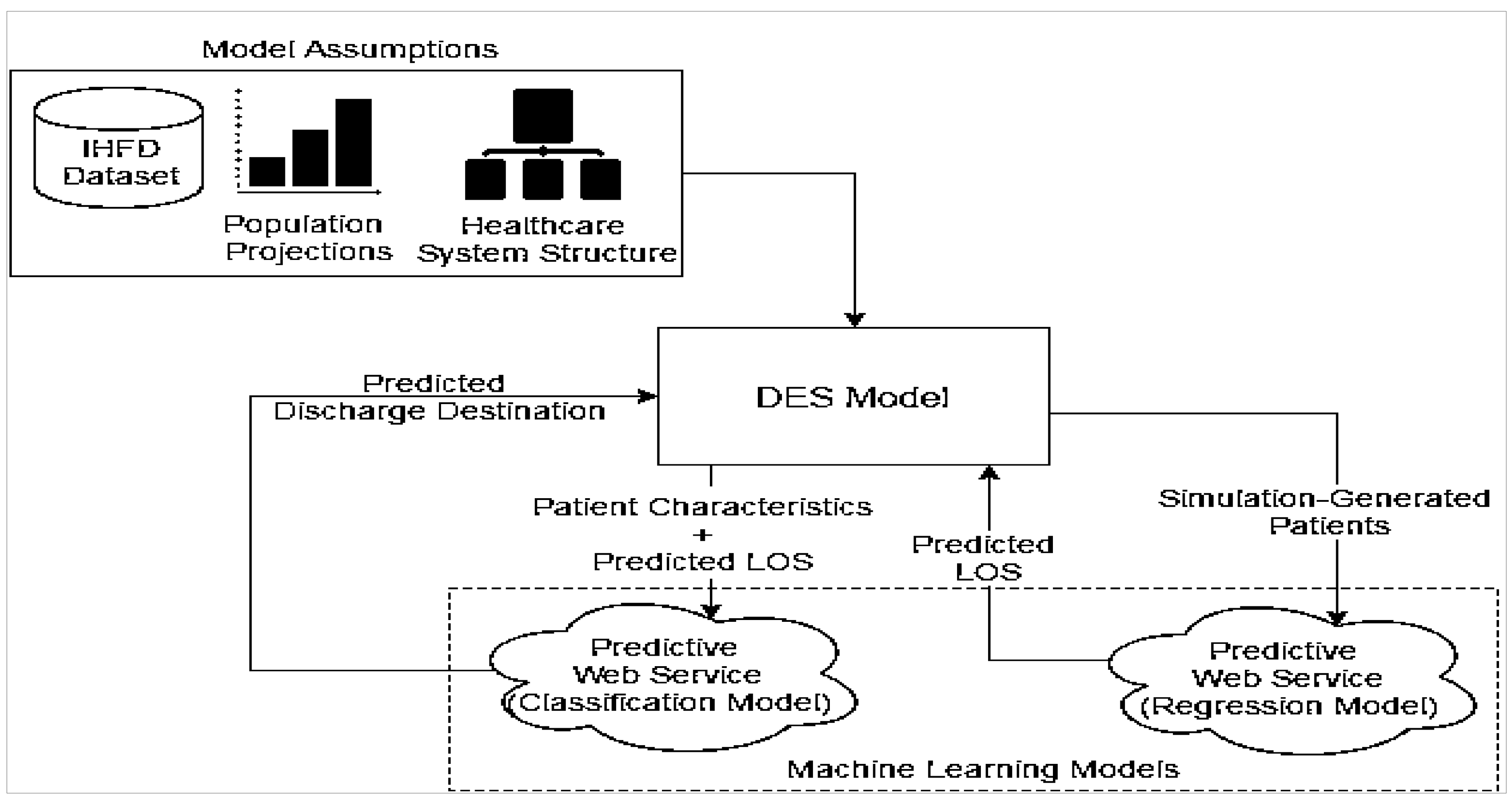
Approach Overview



Use Case: Discharge Planning of Elderly Patients



Use Case: Discharge Planning of Elderly Patients (cont'd)



Conclusions

We argue that the proposed approach can have a set of potential benefits that can improve the predictive accuracy of simulation modeling as follows:

- A different way is presented in order to deal with the uncertainty underlying simulation models by using prediction models, rather than the conventional techniques of random sampling.
- The incorporation of machine learning is claimed to reduce the uncertainty underlying the simulation model, in turn improving its validity and credibility for decision making.
- Further, a simulation model can gain the characteristic of a dynamic behaviour in case that the prediction models are continuously trained using incoming data samples. Even though the structure or assumptions of the simulation model may not change, its behaviour can change as long as the prediction models are being re-fitted to data accumulating over time.