Coupling Simulation with Machine Learning: A Hybrid Approach for Elderly Discharge Planning

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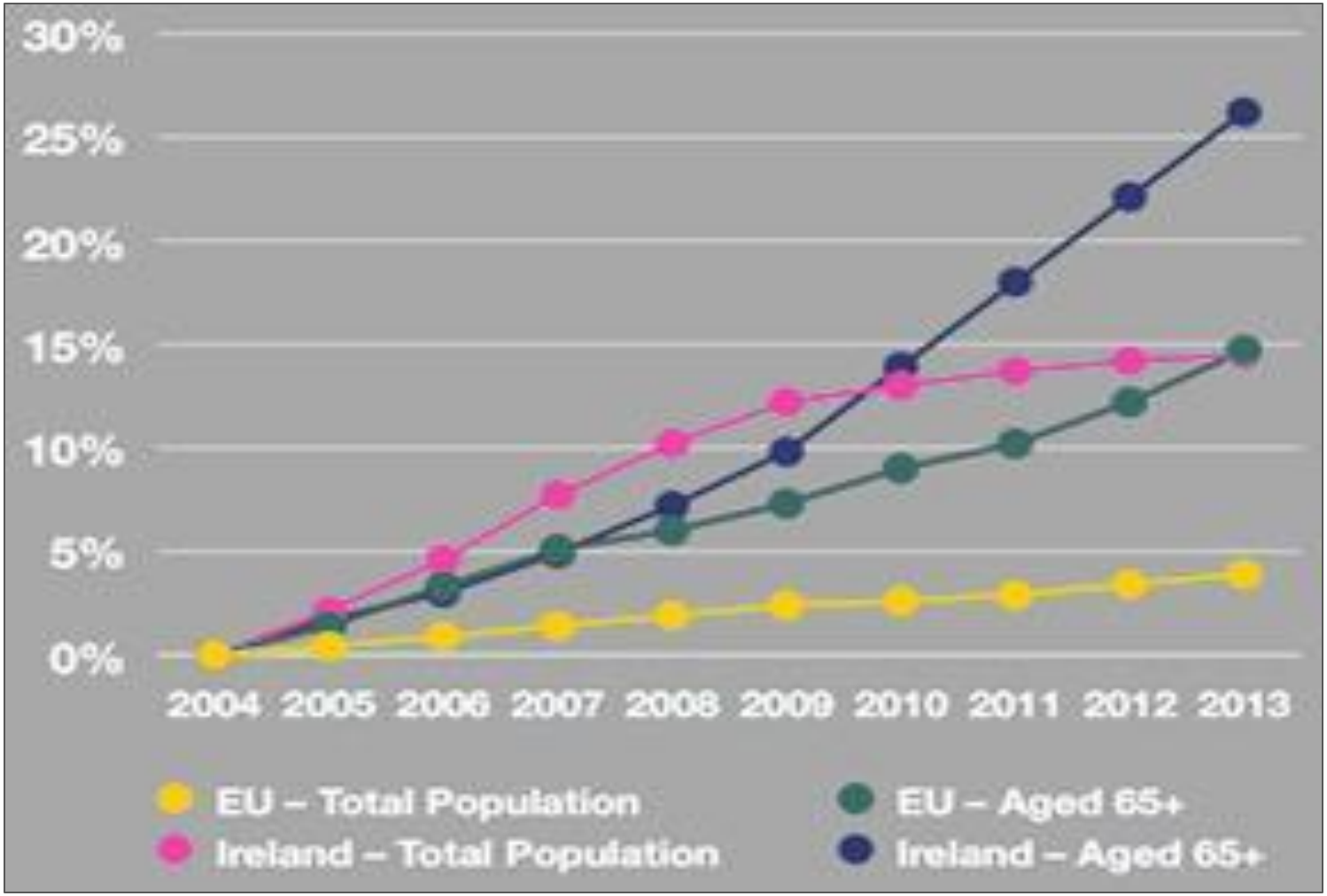
Challenge to Healthcare: Population Ageing



Source : Health Service Executive. Annual Report and Financial Statements, 2014.

Our Focus: Hip Fracture Care in Ireland

- A good exemplar of elderly healthcare.
- Exponentially increasing with age.[1]
- Identified as one of the most serious injuries resulting in lengthy hospital admissions and high costs.[2]
- High quality data available through the Irish Hip Fracture Database (IHFD).

Sources :[1] Gullberg, B., Johnell, O. and Kanis, J.A., 1997. World-wide projections for hip fracture. Osteoporosis international, 7(5), pp.407-413.
[2]http://www.hse.ie/eng/services/publications/olderpeople/Executive_Summary_Strategy_to_Prevent_Falls_and_Fractures_in_Ireland%E2%80%99s_Ageing_Population.pdf

Questions of Interest

Category of Questions	Question
Individual Patient-Level	Q1) Given an elderly patient's characteristics, how to predict the **length of stay** in acute facilities?
	Q2) Given an elderly patient's characteristics, how to predict the **discharge destination**?
Population-Level	Q3) What is the expected proportion of elderly patients discharged to home, or long-stay care?
	Q4) How adequate is the geographic distribution of long-stay care facilities with respect to the demographic profile of elderly people in Ireland?

Our Approach: Integrating Simulation Modeling with Machine Learning

Patient-Focused Perspective

Machine Learning

Predict LOS and
Destination Discharge

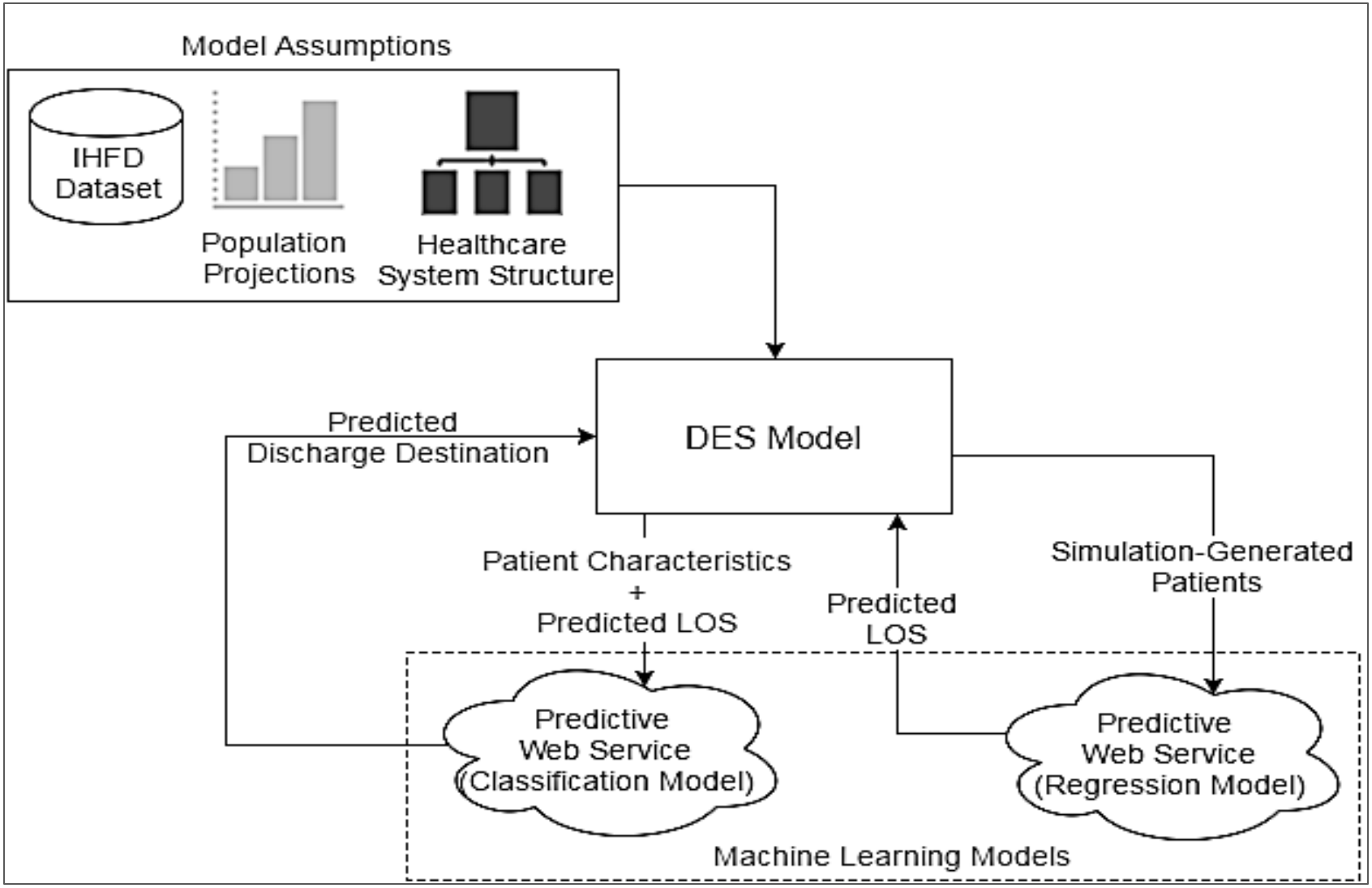
+

Population-Driven Perspective

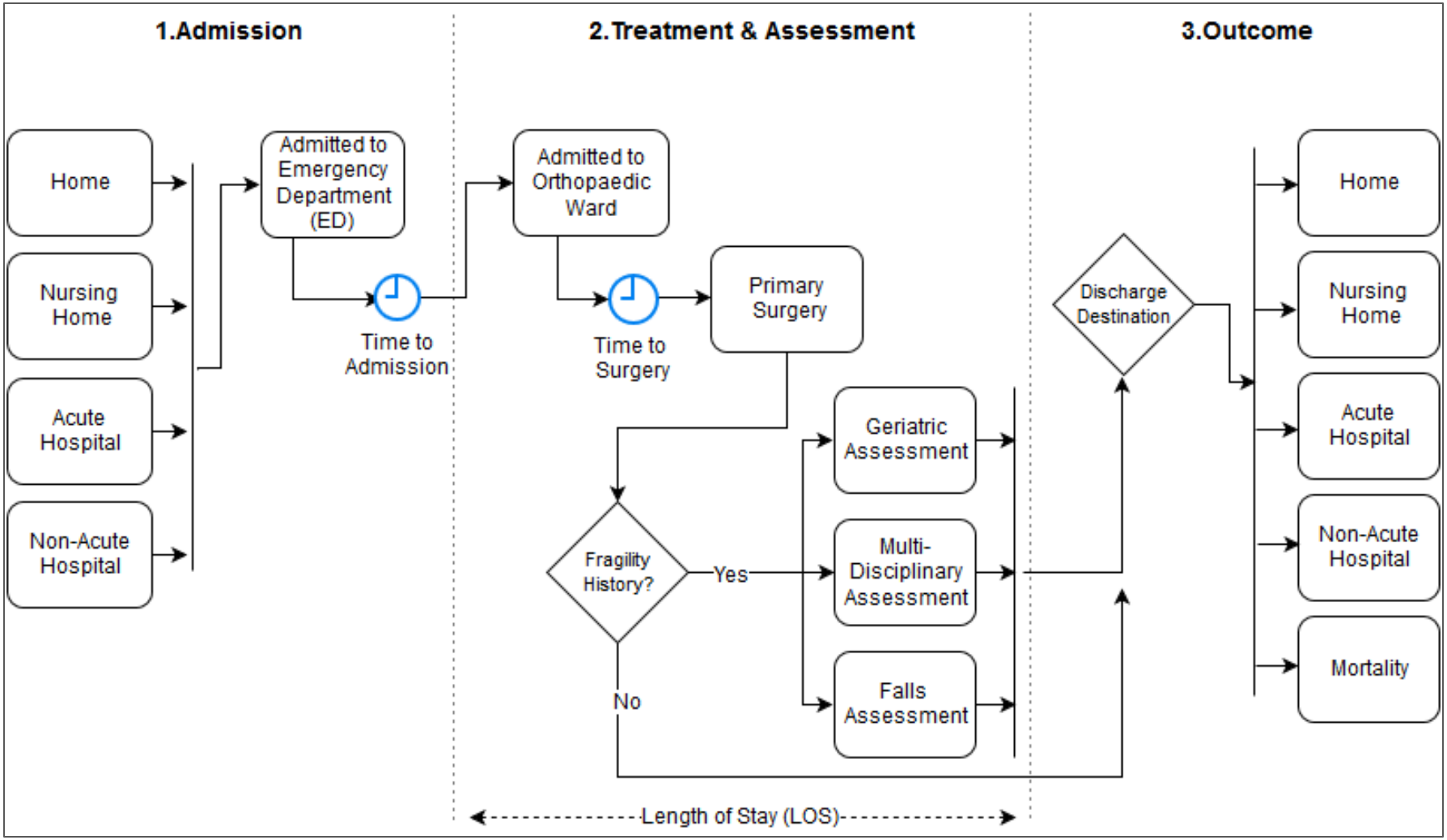
Simulation Modeling

Modeling Projected
Flow of Elderly Patients

Approach Overview



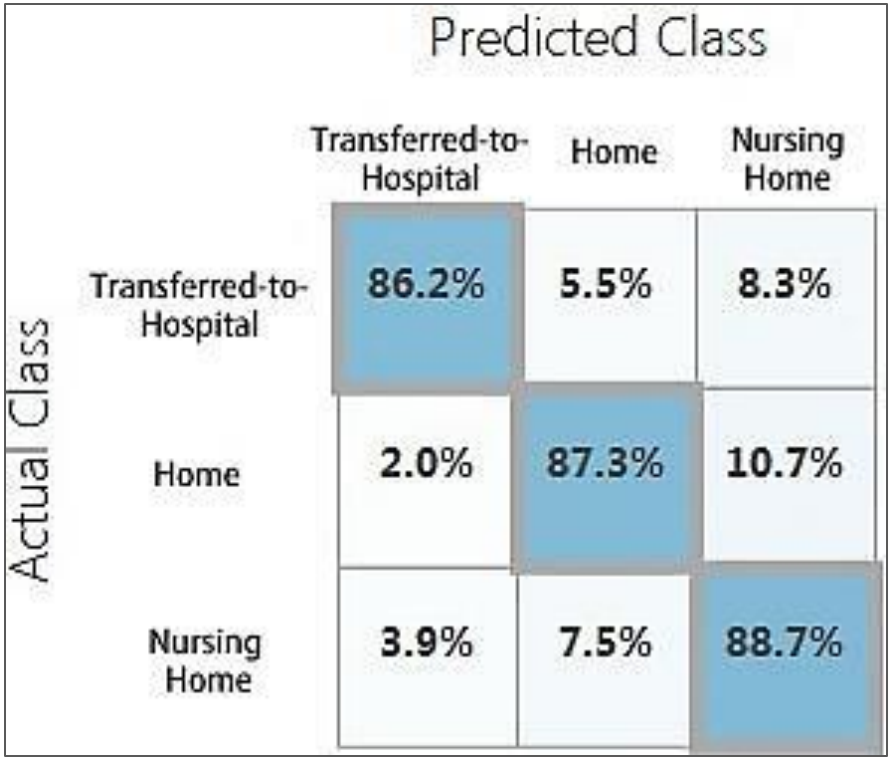
DES Model : The Patient Journey



Models Training

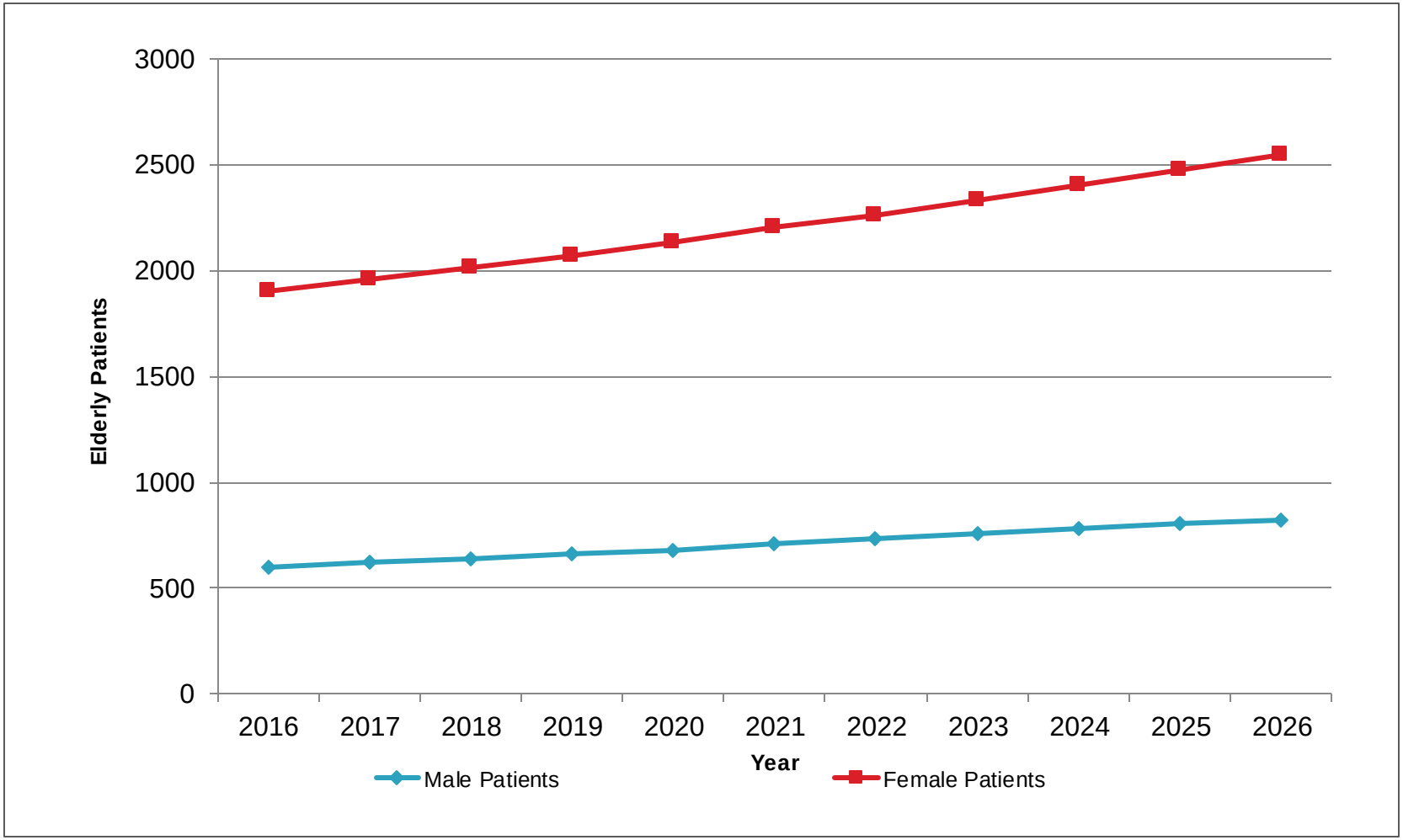
Average 10-fold cross-validation accuracy of the LOS predictor

Relative Absolute Error	Relative Squared Error	Coefficient of Determination
≈0.26	≈0.17	≈0.83

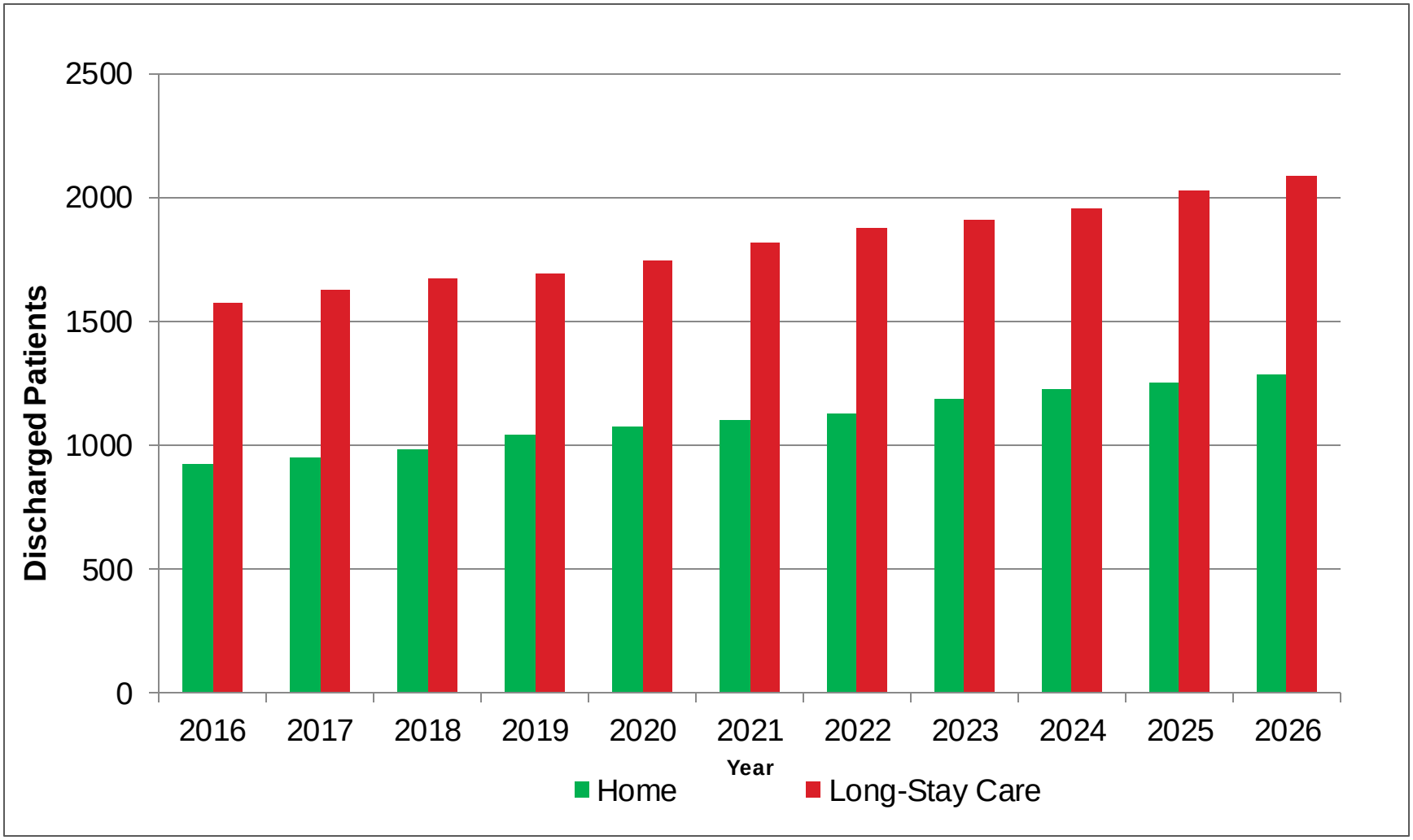


Average 10-fold cross-validation accuracies of discharge destination classifier.

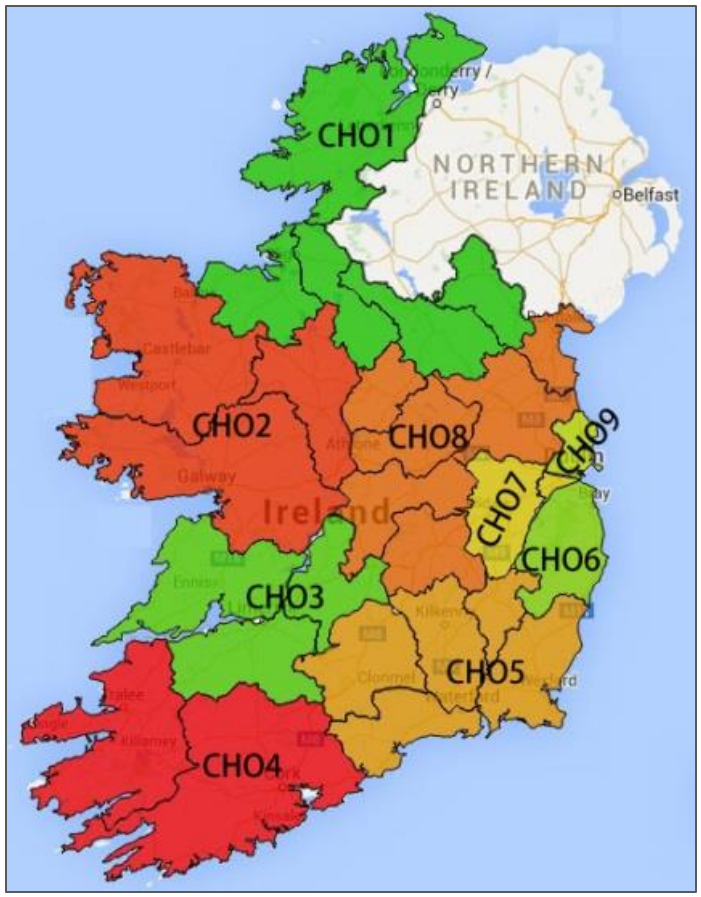
Experiments & Results



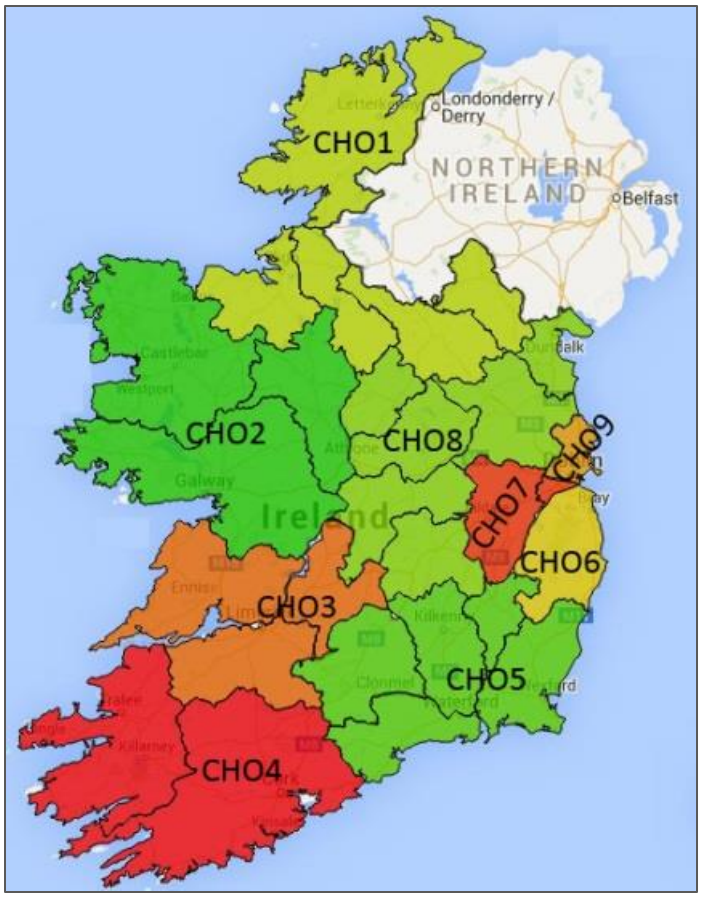
Experiments & Results (cont'd)



Experiments & Results (cont'd)



(a) Bed Capacity (Long-Stay Care)



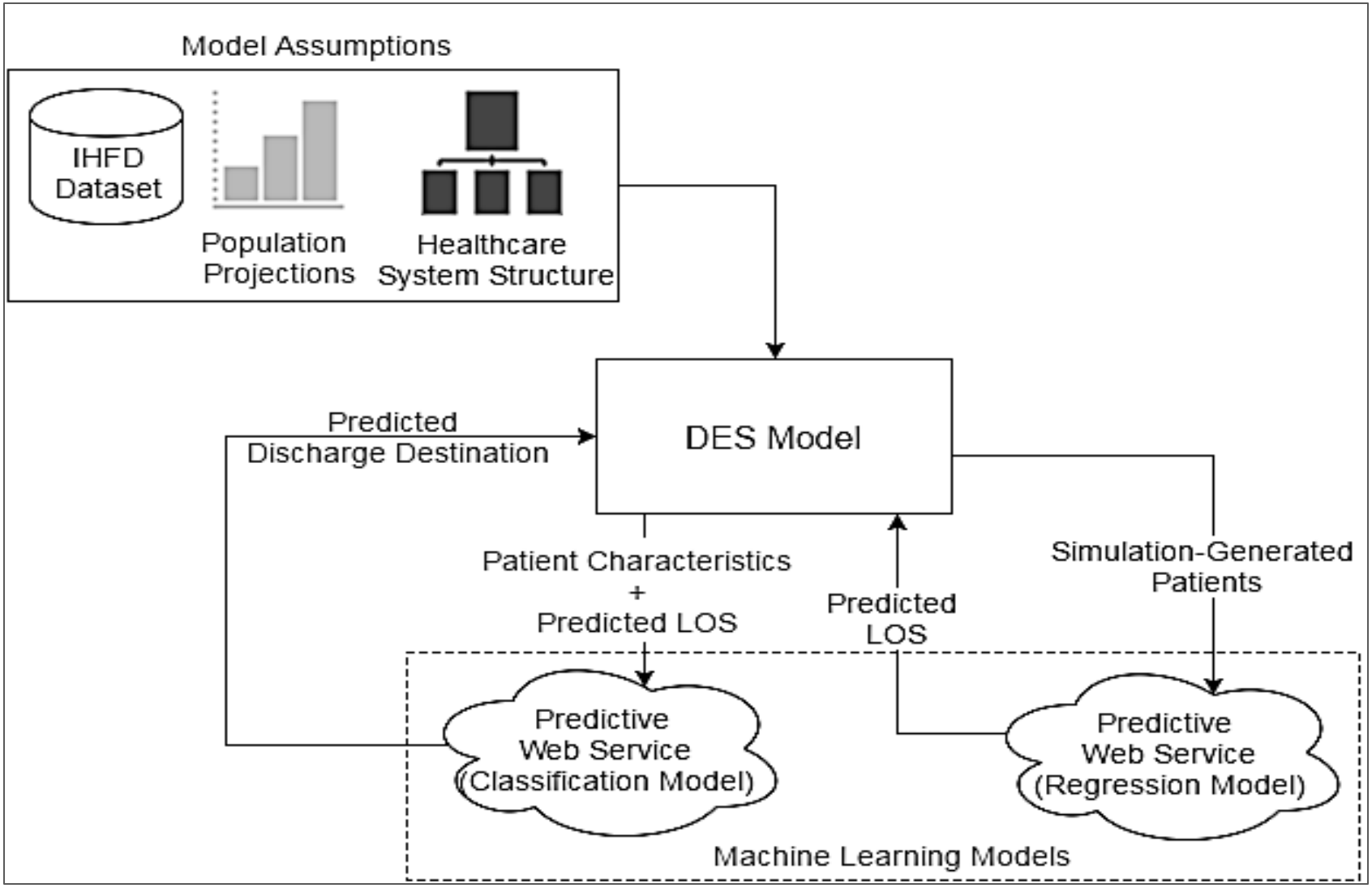
(b) Predicted Demand

CHO: Community Health Organisation

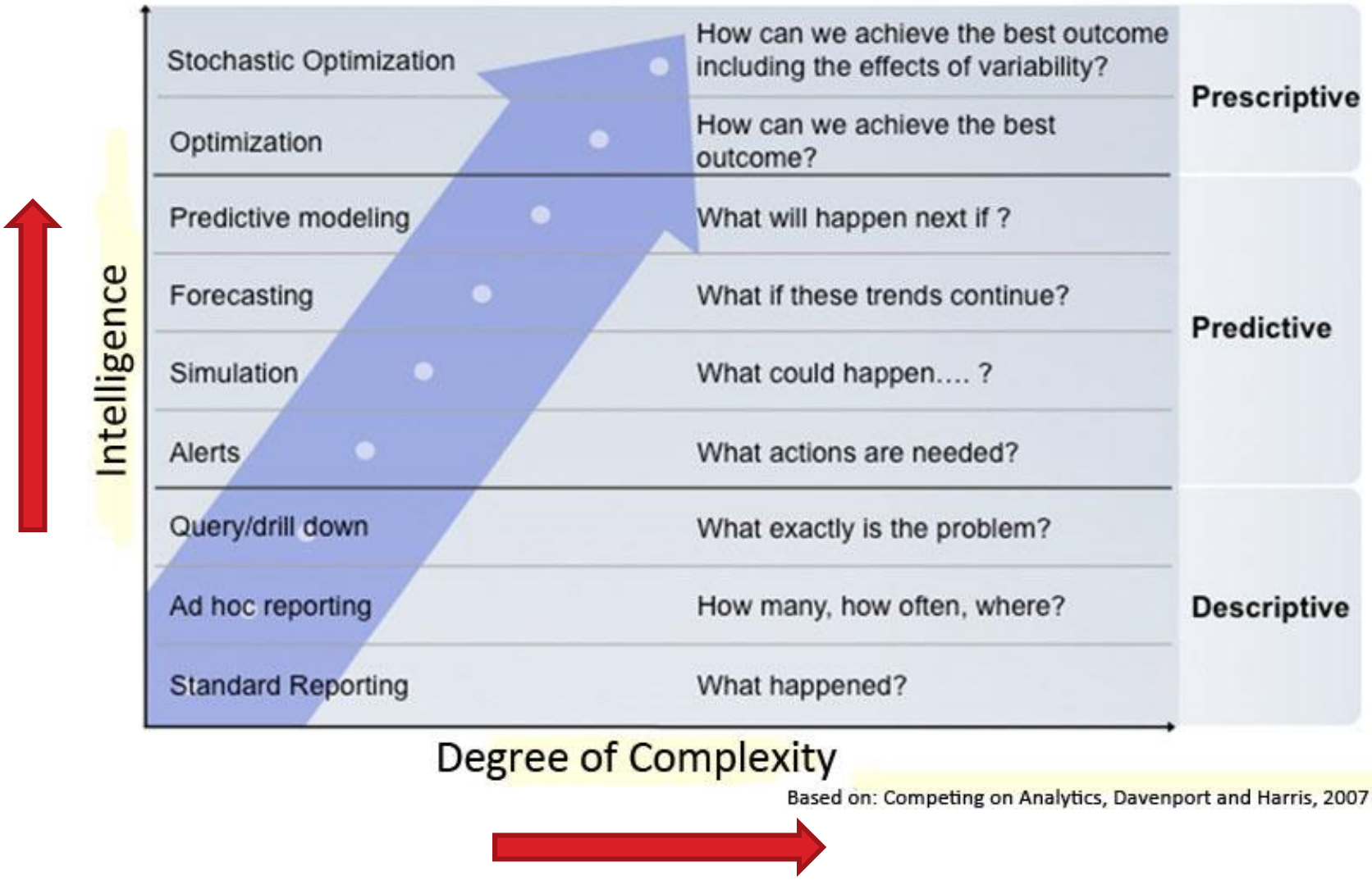
Study Limitations

- Only public acute hospitals were considered, from which the IHFD records were obtained.
- The records of the IHFD dataset did not evenly represent the 9 CHOs.
- The real data obtained by the study covered only a single year, which was 2013.
- The rate of hip fractures was assumed as a constant over the simulated interval, however it might increase or decrease in reality.

Discussion: The Role of Machine Learning



Discussion: The Role of Machine Learning (cont'd)



Based on: Competing on Analytics, Davenport and Harris, 2007

Summary

- The developed model can realise a population-based perspective for care delivery of hip fracture care in particular.
- The combined approach of simulation modeling and ML is claimed to increase the simulation model accuracy.
- Further, the model can further serve as a surrogate model for expecting the potential demand for elderly care in general.

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