

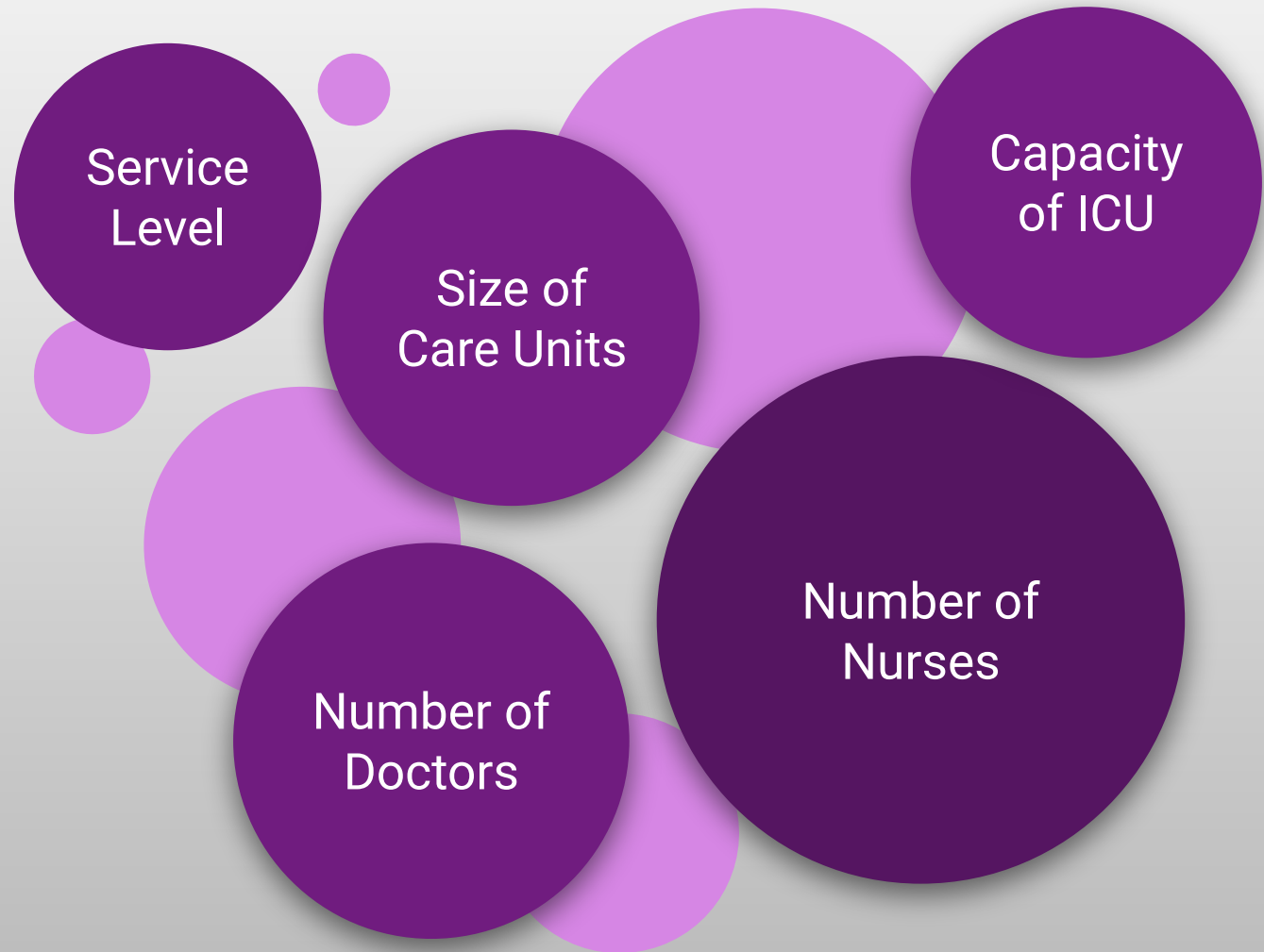
AGENT-BASED MODEL TO SIMULATE PATIENT INFLOW IN AN ICU



*MASTER THESIS OF
VIVEK & KEYVAN*

A Decision Support System for Hospitals

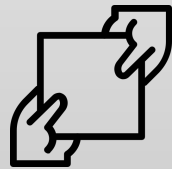
MODELING ICU DYNAMICS



MODELING ICU DYNAMICS

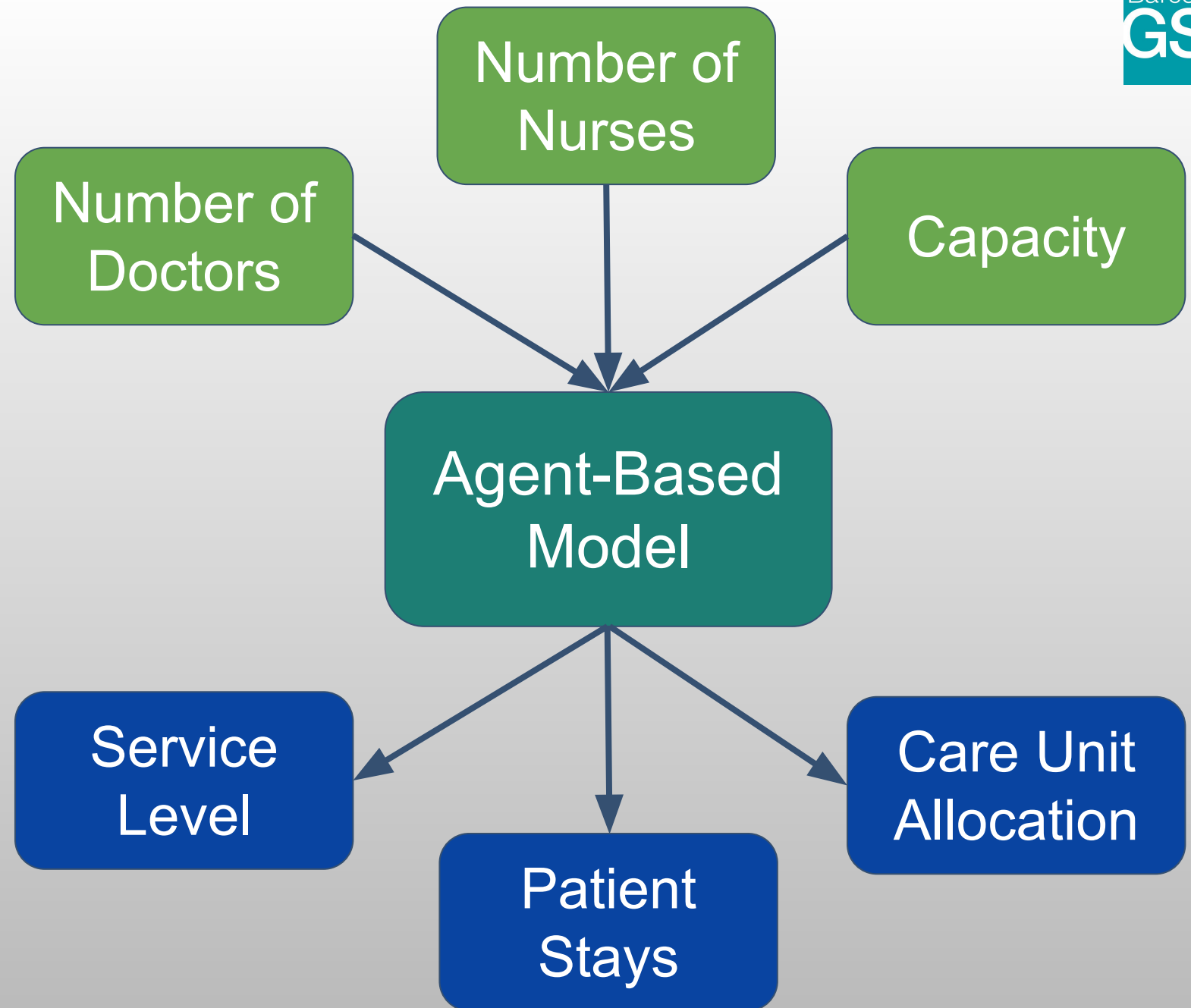


Close links between predictions for mortality and length of stay recorded in the literature



Utilize knowledge acquired in binary model for the predictive model in the ABM

MODEL OVERVIEW



MODEL PROCESSES

Step 1

New agents are initialized

Step 2

Some patients enter the ICU if capacity is available

Step 3

Patients receive care from doctors and nurses

Step 4

Prediction about patient's outcomes at the end of the day

Step 1

New agents are initialized



Random draw of the number of incoming patients



Simulate each patient

- Draw age, medical condition, gender and vital signs based on empirical distributions

MODEL PROCESSES

Step 2

Some patients enter the ICU if capacity is available



Check the number of available beds

- Add patients to the ICU until it is full

MODEL
PROCESSES

Step 3

Patients receive care from doctors and nurses



Patients receive caretime units for doctors and nurses

- These units accumulate and are used in the prediction model

MODEL
PROCESSES

Step 4

Prediction about patient's outcomes at the end of the day



Prediction of outcomes with 1 day time horizon

- Trained on daily snapshots of the MIMIC data
- Determines if the patient stays, dies or is discharged



Return to Step 1 on the next day

MODEL
PROCESSES



Prediction of outcomes with 1 day time horizon

- Trained on daily snapshots of the MIMIC data
- Determines if the patient stays, dies or is discharged

Key Features

DEATHRATE_CAT_1.0

DEATHRATE_CAT_2.0

mechvent

days_since_admission

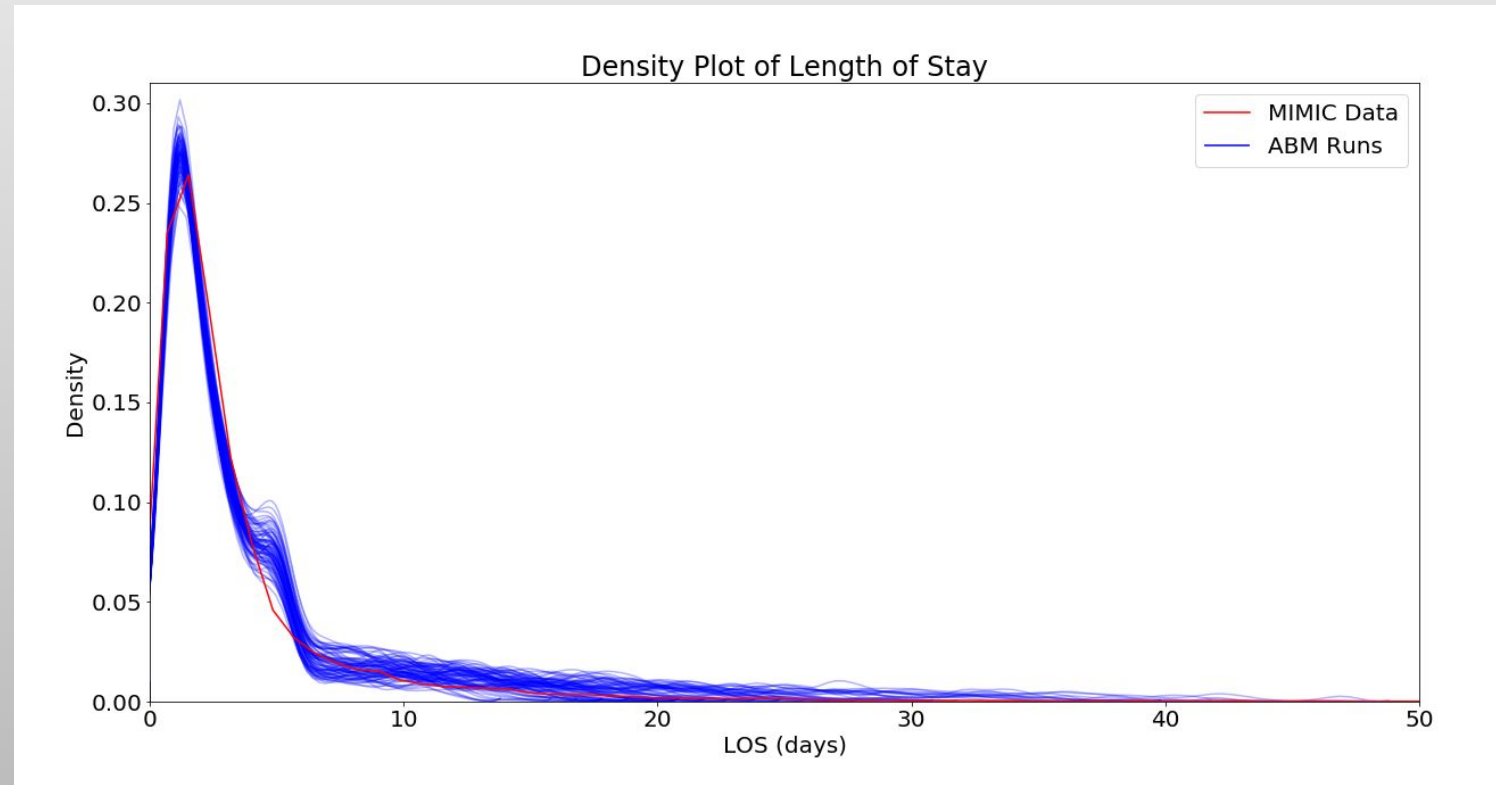
MODEL
PROCESSES



Length of Stay Dynamics

- Overall matches the data, other than days 6 to 7

MODEL
DYNAMICS

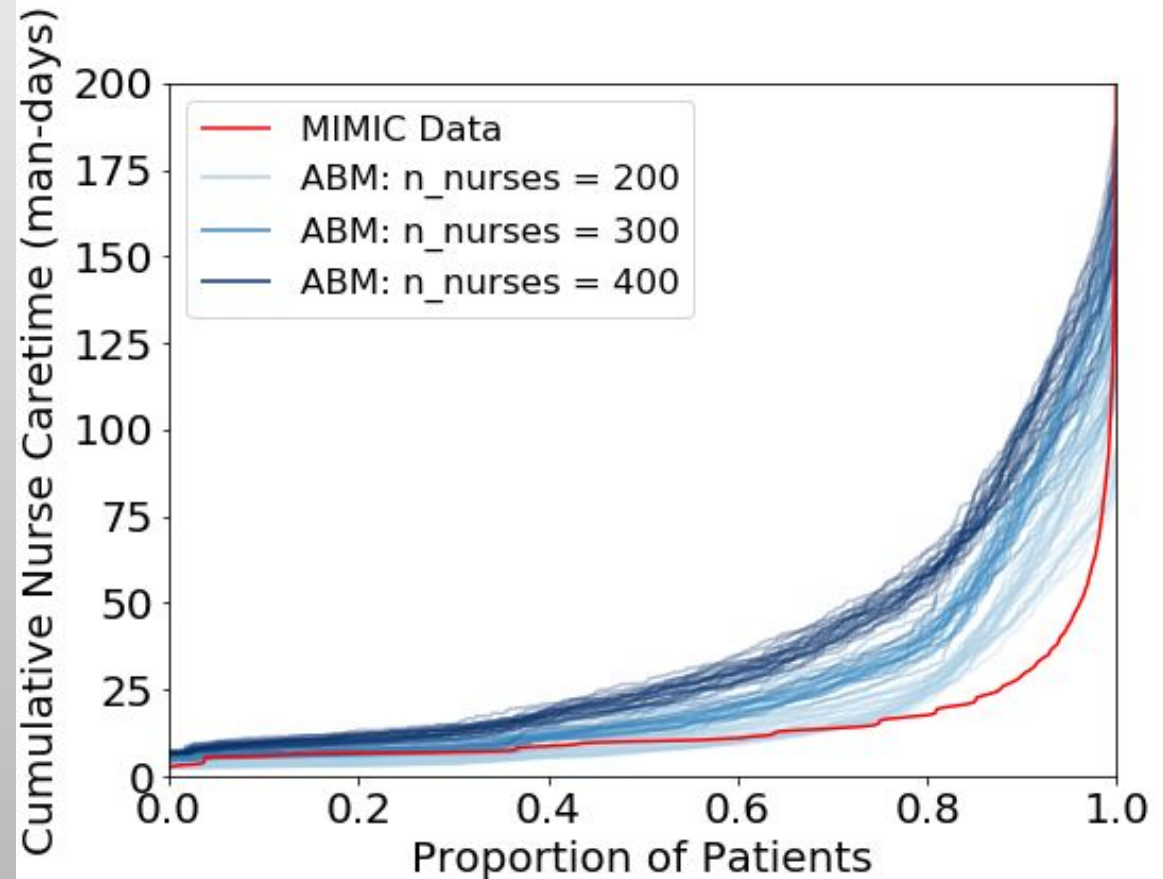


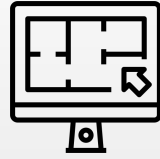


Cumulative Nurse Caretime Dynamics

- Ordered patients by cumulative caretime
- Model works well for 80% of patients

MODEL
DYNAMICS

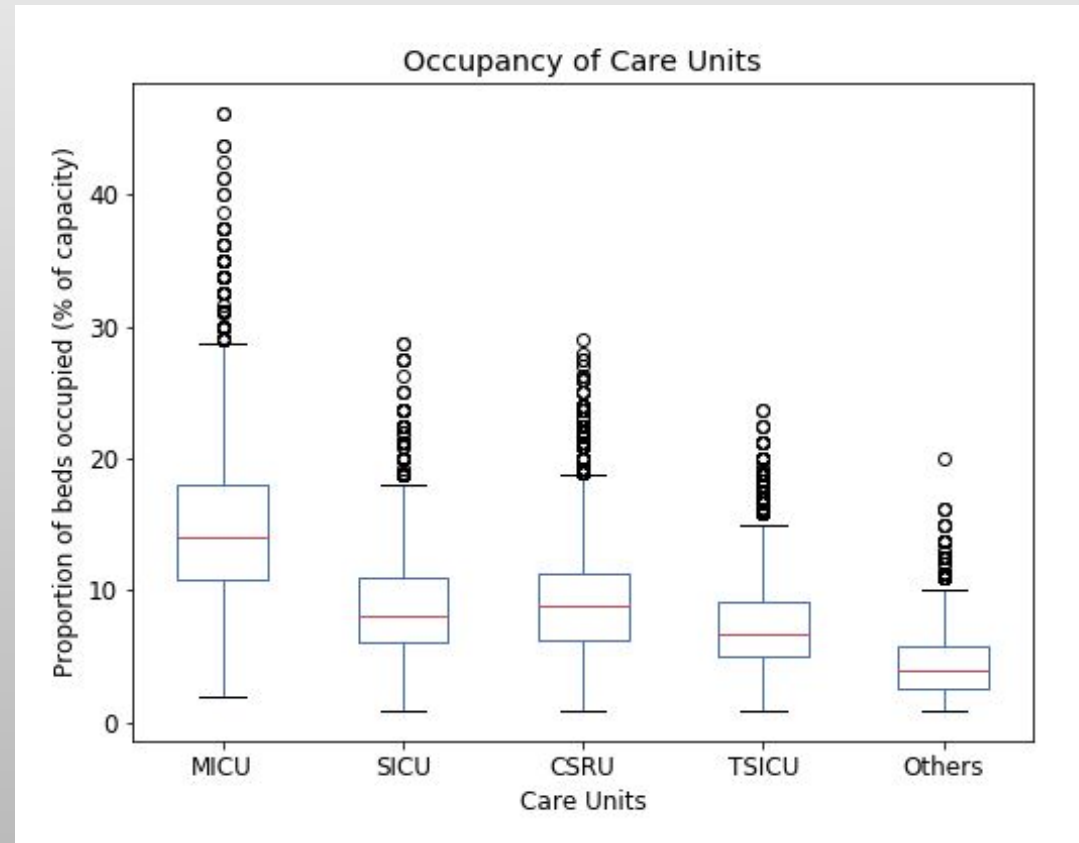




Care Unit Allocation

- Model runs provide a suggestion for allocation of beds in the ICU

MODEL
OUTPUT



OUTLOOK



Make use of our *Mortality prediction* model



Introduce more complex interactions between caregivers and patients into our ABM



Incorporate other performance metrics like costs and longer-term medical outcomes

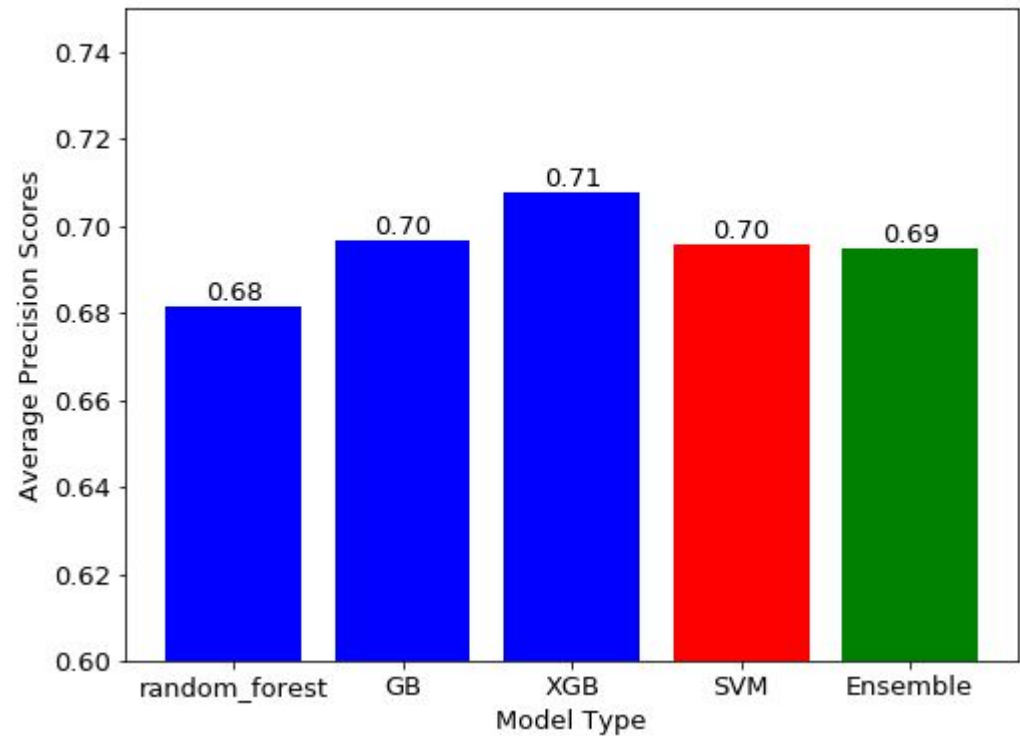
Additional useful information



Prediction of outcomes with 1 day time horizon

- Ran ABM with SVM and XGB
- Final choice: SVM

MODEL PROCESSES

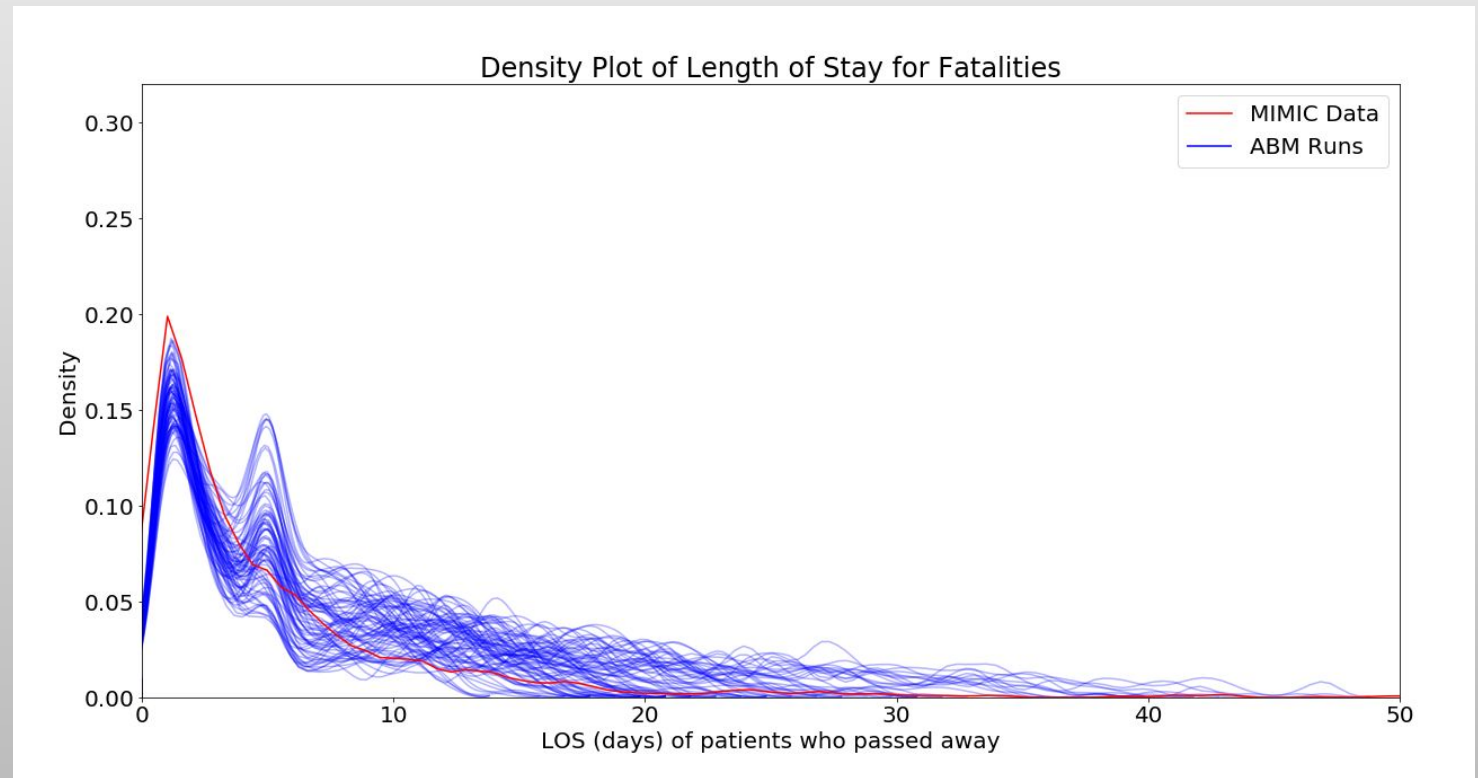


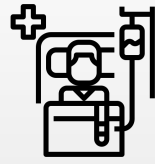


Length of Stay Dynamics for Fatalities

- SVM significantly outperformed XGB here

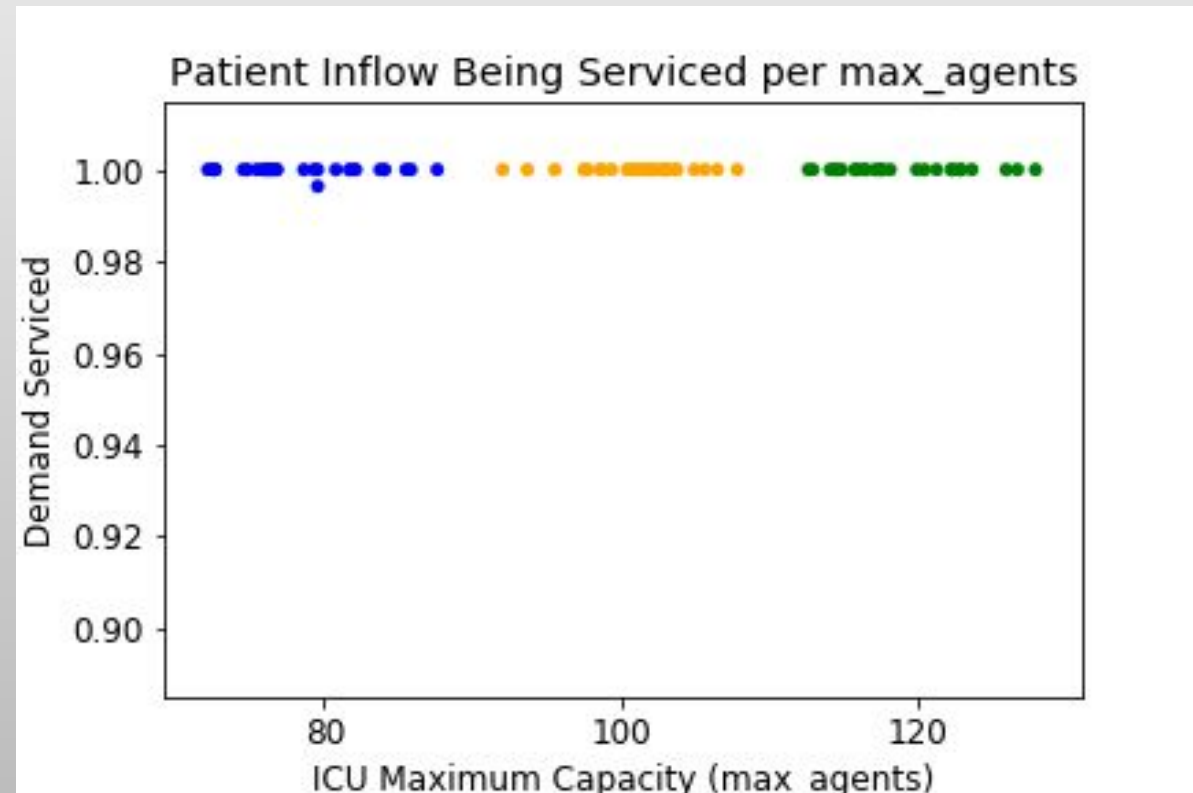
MODEL
DYNAMICS



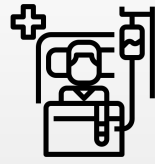


Service Level Dynamics

- All around 100% here due to parameters
- Can give the likelihood of meeting a desired level of service

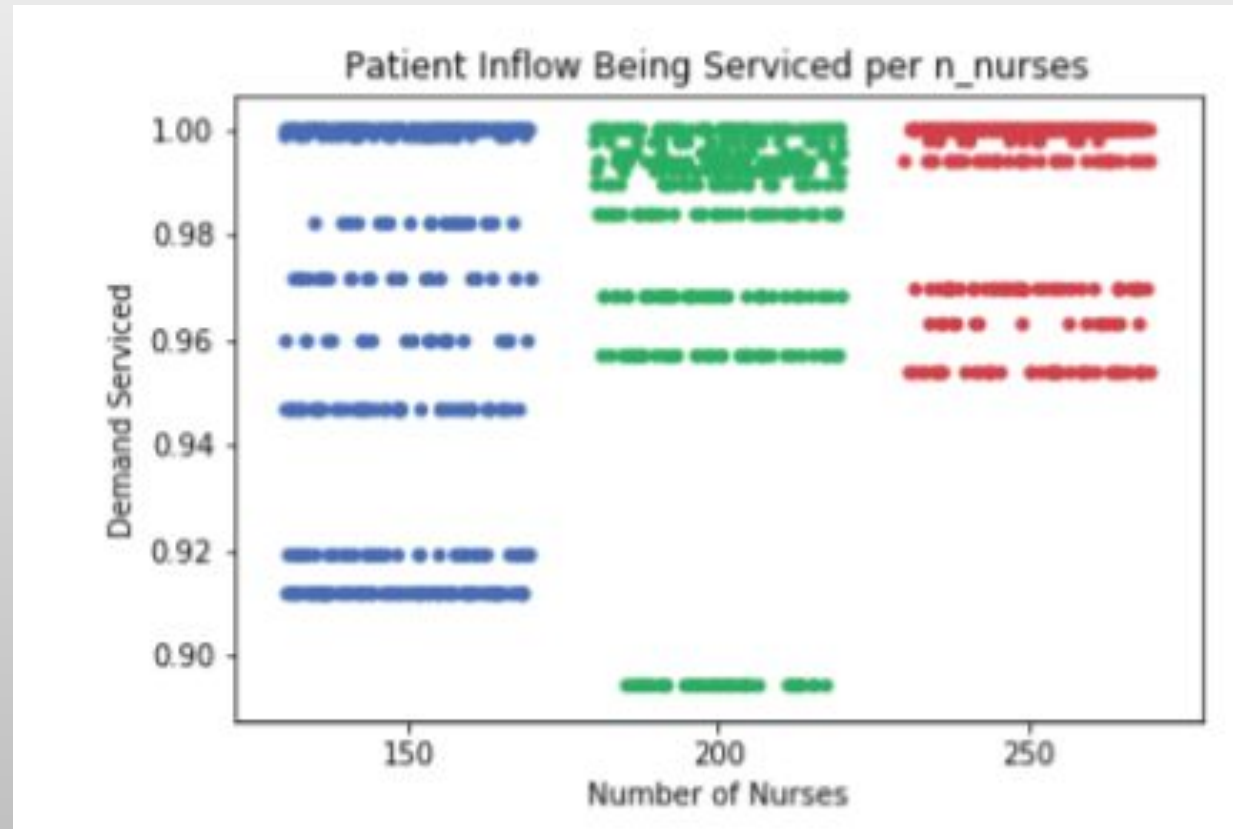


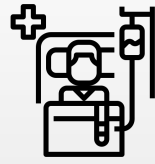
MODEL
OUTPUT



Service Level Dynamics

MODEL
OUTPUT





Service Level Dynamics

MODEL
OUTPUT

