Motivation
Deinstitutionalization of psychiatric care in the 1950s and the subsequent lack of community-based programs to treat those affected by this has resulted in a severe mental health crisis throughout the United States and a significant decrease in the capacity to treat patients. A specific effect is the number of patients in need of psychiatric care visiting Emergency Departments (ED) and experiencing extended delay in treatment while awaiting placement in an appropriate Inpatient Facility (IP). For boarding to be decreased, arrival dynamics of facilities within the psychiatric network must first be understood.

Data
Minnesota has developed an online tool to aid social workers in transfer placement. Notifications are sent to social workers when a capacity at a hospital as increased by 1 bed.

Each Notification Contains:
1. Facility Name
2. Facility Address
3. Distance from original facility (Mayo Clinic)
4. Available Capacity
5. Age Range (Adolescent, Adult, Geriatric, Pediatric)
6. Transfer requirements or notes

The Problem
- Notifications are only generated when a bed becomes available
- No notifications when a bed is taken
- Difficult to understand capacity dynamics

Model and Methodology
The option to transfer patients to any hospital within the network allows modeling as an Open Jackson Queue Network.

Each site becomes an M/M/m queue but $\lambda_{site}$ and $\mu_{site}$ are both unknown
For consecutive capacity notifications $c_t, c_{t+1}$:

$$n_{arr,t} = \begin{cases} 
c_t - c_{t+1} + 1, & \text{if } c_t > c_{t+1} \\
0, & \text{if } c_{t+1} > c_t
\end{cases}$$

$$\lambda_{site} = \frac{\sum n_{arr,t}}{t_{final} - t_{first}}$$

Assumed Capacity Dynamics

Bed usage % and patient length of stay calculated from queueing theory:

$$\rho_{avg} = \frac{\sum b_{tot} - c_t}{\# \text{notifications}}$$

$$\mu_{site} = \frac{\lambda_{site}}{\rho_{avg}}$$

Arrival rates must be adjusted for origin site influence:

$$\lambda_{external} = \lambda_{calculated} \times \left[ 1 - \frac{\# \text{ of Origin } \rightarrow \text{Site}\Delta}{\# \text{ notification}} \right]$$

Results
Due to the size of the network it is logistically difficult to verify every calculated metric. Utilization and arrival rates for some sites appear reasonable. Sites with few reports of open beds result in irrationally large values.

Future Work
The values found here can be used as input parameters for a discrete event simulation that can be used for optimization.

Questions we aim to answer are:
1. When is it better to request transfer to a facility that may be farther away?
2. When is it better to wait before requesting to transfer in case a bed at the current facility becomes available?
   - Particularly important for children & geriatric patients
3. What is the impact of community-based interventions on ED boarding, IP utilization rates etc.?

These questions aim to reduce the waiting period patients experience before receiving treatment which ultimately benefits the patient and reduces the overall burden on the healthcare system.