**Motivation**

During extreme weather (blizzards, severe thunderstorms, minor hurricanes, etc), ambulances are often overwhelmed by the number of patients. Due to the size of the area affected, assistance from outside the jurisdiction may not be available and patients queue while awaiting service.

**Basics**

- Finite-horizon continuous-time Markov decision process (MDP) solved by backward induction
- Seek to minimize the total expected penalty

**Patients**

Patient type changes over time as their condition degrades

- **Low-priority:** Non-emergent patients. e.g. Minor trauma
- **High-priority:** Emergent patients. e.g. Cardiac arrest
- **Critical:** Emergent patients unlikely to survive to hospital discharge.
- **Underserved:** High-priority patient being served by BLS ambulance.

**Ambulance**

- **Basic Life Support (BLS):** Served by EMTs.
- **Advanced Life Support (ALS):** Served by at least one paramedic.

**Penalties**

- High-priority and under-service penalties represent decrease in survival to hospital discharge
- Critical and low-priority penalties are customer service dissatisfaction

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**Policy Results**

- **Immediately Serve High-Priority Patients**
  - Unaffected by any sensitivity analysis or change in rates.
  - If only BLS are available, still send them.

- **Withhold an Ambulance to Serve Emergent Patients**
  - This includes BLS ambulances if all ALS ambulances are currently in service.
  - Number of ambulances withheld increases if ambulances are taking a long time to serve, as in a bad snowstorm, or the rate of high-priority arrivals is great.

- **With Long Queues, Serve Low-Priority in Order of Severity**
  - Arises implicitly from the policy data.
  - As the size of low-priority queue increases, service to the queue stops.
  - Model assumes no knowledge of severity.
  - Ambulances wait for them to convert to high priority (when knowledge of ‘worst’ patients becomes obvious).
  - In practice, it is better for customer service to serve likely emergent low-priority patients sooner.

- **The Value of Converting a BLS Ambulance to ALS is in Serving Critical Patients**
  - Extra ALS ambulances should serve critical patients not low-priority.
  - It is still preferable to have BLS service critical patients and reserve ALS for high-priority if possible.
  - Upgrading BLS to ALS leads to greater withholding overall.
  - Only in majority ALS systems should ALS be downgraded to serving low-priority patients.