SCREENCAST OUTLINE

2) In Boston, thousands of requests are made each week to Boston 311 to report non-emergency issues such as graffiti, potholes, and broken traffic signals.

3) Traditionally, these requests have been made through phone calls, but because smartphone technology became increasingly common, the city of Boston developed the Citizens Connect app as another way of reporting problems to 311.

4) Does this app facilitate more efficient responses to different parts of the city compared to requests made by calling? We modeled and compared the joint distribution of response times and locations for 311 requests made via phone calls and those made via the smartphone app.

4) We obtained data on longitude, latitude, and length of time to close a 311 request in 2015 from the city of Boston website

5) The distribution of requests from calls contrasts with the Citizens Connect App, with the latter being more highly concentrated around the Downtown and Back Bay areas.

6) We therefore chose to model the 311 data with Gaussian mixture models, where we approximate our data with multiple Gaussian components. Each 311 request datapoint is a 3D vector described by response time, longitude and latitude. We seek to find the mixture coefficients, the component means and covariance matrices, and which component each point belongs to.

7) Our first challenge was to determine how many components should be used to describe our data. We used expectation maximization to calculate the maximum likelihood and maximum a posteriori estimates for models ranging from two to six components. We then calculated the Bayes Information Criterion and found that a 3-component model was optimal based on the maximum a posteriori estimates. On the other hand, maximum likelihood tends to overfit data.

8) The MLE obtained through EM was used to initialize the maximum a posteriori estimates, also performed through EM. The component assignments obtained through the maximum a posteriori estimate are shown below, both in all three dimensions and projected onto the longitude-latitude plane. The dark green cluster shows that the largest population of requests are resolved in a matter of days. The smallest cluster, in orange, shows that a group of requests take much longer to resolve, on the order of months. The app and phone call data components show a similar separation in response times. However, while the slow requests seem to be distributed throughout Boston for phone calls, the slow requests are concentrated in the downtown area for the App.

9) We then used simulated annealing to estimate our model parameters and compared to the EM results. Qualitatively, the results are similar, but simulated annealing takes much longer to converge even when running on a smaller random sub-sample of datapoints.

10) To generate the posterior distributions, we used Gibbs sampling. Our priors were selected so that the conditionals had closed forms, which makes Gibbs sampling more efficient than standard Metropolis-Hastings. Examining the traces suggested that the sampler converged within about 150 iterations.

12) Compared to the EM results shown previous, the Gibbs sampler identifies a larger cluster of the slowest response times. However, we still find that the app and phone calls have similarly efficient response times based on the distribution of these components along the response time axis, and that the slower responses for the app are shifted more toward the northeast of Boston. The posterior predictive distribution suggests that the model captures some of the geographic differences between the two types of requests and the spread in response times, although a better model is needed to fit for the very longest response times.

13. To understand what characteristics distinguish these clusters of requests, we retrieved the distribution of requests by department in each cluster. The department volume profiles indicate that different departments dominate the clusters for the app and phone calls, even though the clusters have similar response times. Overall, our results suggest that while the app and phone calls have somewhat different service needs and geographical origins, they are served with a similar degree of efficiency.