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DATE: 1/21/19
Homework: 01
STAT/CS 387

Problem 1

1. These data are characterized by a Binomial random variable as each battle is fought independently of other battles and there is only a success or fail outcome. In addition, each battle is a Bernoulli trial since each battle with an MK1 or MK2 has the same likelihood for success, p.

2. The probability that MK2 is deadlier than MK1 is .965 (line 51). I get this probability by taking the mean of the delta samples that are less than 0, as delta is defined as MK1-MK2. In Fig 1 we see that the mean of the MK2 distribution is larger than for MK1, so we can conclude they are more deadly.

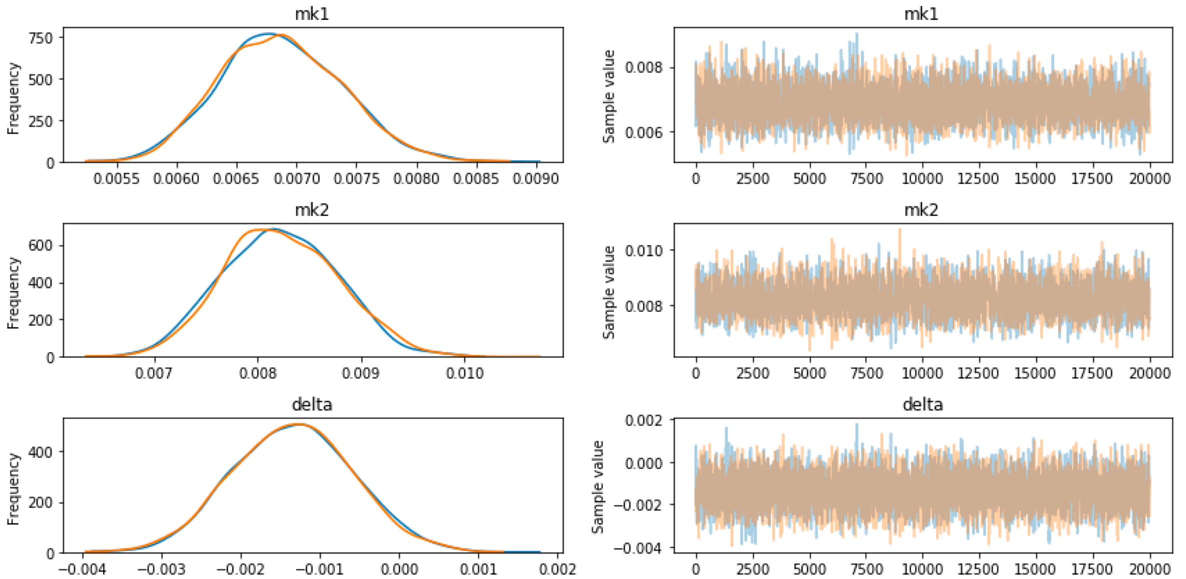

Fig 1: Trace-plots and posterior distributions of MK1, MK2 and delta.

Problem 2

1. When implementing this problem I was not able to successfully download pymc as I got errors because I have tensor flow downloaded on my laptop. I was able to download pymc3 though, and found a great resource for code and instruction at https://nbviewer.jupyter.org/github/CamDavidsonPilon/Probabilistic-Programming-and-Bayesian-Methods-for-Hackers/blob/master/Chapter1_Introduction/Ch1_Introduction_PyMC3.ipynb. As shown in the trace-plots in Fig 2, the sample converges. To show convergence the trace plot must look like a random walk that has a slope of zero, so it does not diverge (line 82). I also computed the Gelman-Rubin statistic (line 81). Values less than 1.1 converge for the Gelman-Rubin statistic, and all parameters return almost exactly 1.

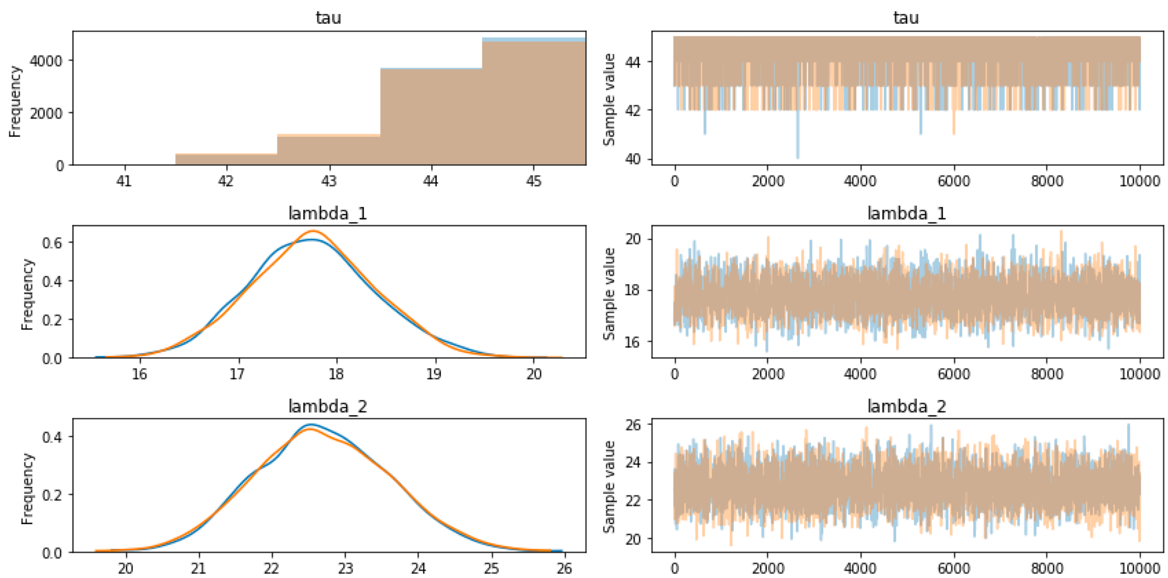

Fig 2: Trace-plots and posterior distributions of tau, lambda_1 and lambda_2.

2. I propose a logistic function to smoothly change the poisson rate, $f(t) = \lambda_1/(1+e\hat{}(t\varphi_1+\varphi_2))+\lambda_2$ and. As logistic functions only range from (0,1) , I had to figure out how to shift the curve up between the two lambdas and right to around 43 days when the switch occurs. The parameters φ_1 and φ_2 control this shift up and to the right. Appropriate priors for these parameters would be a normal distribution with a mean of zero. After performing bayesian inference with my function f I see that the posteriors converge again as the Gelman-Rubin statistic is 1 for all parameters (line 116) and the trace-plots in Fig 3 have slopes of zero (line 115). In Fig 4, I have plotted the expected poisson rate over time with a 95% confidence interval (lines 119-142). The confidence band is incredibly small as the standard error reported is very small.

This plot supports our earlier switch point model as it has a nearly identical graph, other than from t=40-45 as this is where the switch occurs.

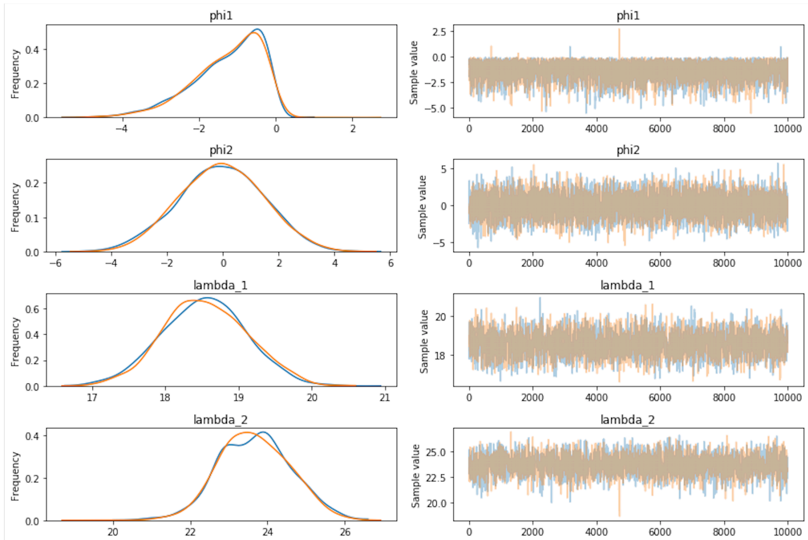

Fig 3: Trace-plots and posterior distributions of phi1, phi2, lambda_1 and lambda_2.

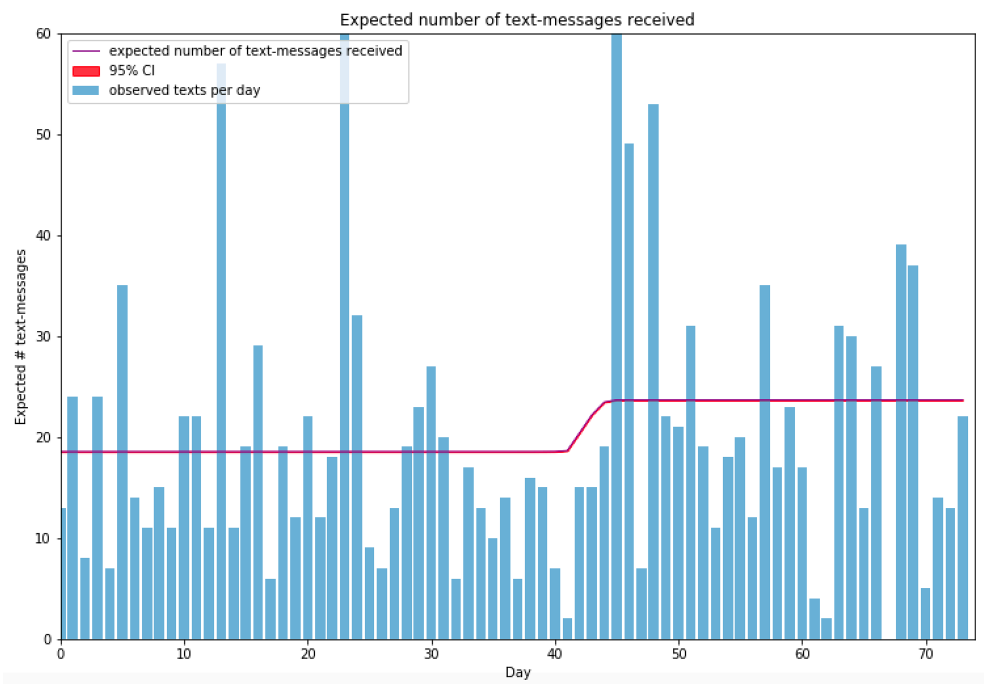

Fig 4: Expected poisson rate over time with 95% CI using f(t)

3. I feel that the original model is better justified as it is more interpretable. As we can understand tau as the day where the rate of texts changes, it is less clear exactly what φ_1 and φ_2 represent.