1 β and ρ parametrizations

There are two ways which I have tried parametrizing distance decay functions in my models. The first, used in the Pope paper, relies on a multiplicative β term to scale the rate of distance decay. E.g.,

$$ln(\lambda) = -\beta|x_1 - x_2|$$

β in this case is a small positive real. In my simulations is receives values from 0.01 - 0.1 although of course this would vary based on the units of distance (e.g., meters, kilometers, etc.). I assign it a prior,

$$\beta \sim \mathcal{N}(0, 0.1)$$

and it is restricted to positive values in the `parameters` block.

An alternative parametrization, following from Mike's chapter on the exponentiated quadratic function, is to use a divisional length scale ρ, such that

$$ln(\lambda_{ik}) = -\frac{1}{2}\left(\frac{|x_i - x_k|}{\rho} - \theta floralquality_k + \mu + \epsilon_k + \zeta_c\right)^2$$

$$\rho \sim \mathcal{N}(100, 50)$$
$$\theta \sim \mathcal{N}(0, 1)$$
$$\mu \sim \mathcal{N}(0, 1)$$
$$\epsilon_k \sim \mathcal{N}(0, \sigma)$$
$$\zeta_c \sim \mathcal{N}(0, \tau)$$
$$\sigma \sim \mathcal{N}(0, 1)$$
$$\tau \sim \mathcal{N}(0, 1)$$

$$\rho_{raw} \sim \mathcal{N}(ln(100), 0.5)$$

$$\rho = exp(\rho_{raw})$$

where ρ (at least in my case) is a large positive real. For me, realistic values would be on the range 50-150. I initially gave it a prior,

$$\rho \sim \mathcal{N}(100, 50)$$

which is probably a bit too wide, to be fair.

2 Model convergence

As I mentioned previously, the β parametrization of the model frequently leads to divergent transitions, especially for (1) small sample size and (2) large foraging distance (e.g., small(er) β). After seeing the ρ parametrization, I started to wonder if perhaps the issues with β were a result of the prior being zero-centered, when zero-centering implies infinite foraging distance (e.g., distance has no effect on visitation rate).

I thought at first that this was a general problem resulting from lack of data, and you suggested that perhaps it was an issue of unidentifiability between two parameters (for example, β and θ (the parameter governing floral attractiveness, which I have ommitted here for simplicity)). However, playing around with these two different paramerizations has led me to believe that the issue is actually with the β parametrization more generally!

I believe that β is a tricky parameter to estimate because as $\beta \rightarrow 0$, the decay function flattens and all distances are equally likely. The region close to $\beta = 0$ would also have high posterior density in cases where visitation is not highly localized (e.g., when foraging distance is large). In the limit, $(\beta = 0)$, the visitation function would depend entirely on other parameter values (e.g., resource quality, colony/trap specific intercepts). This is likely exacerbated for small sample size because the prior (centered at 0) dominates.

I am not entirely sure why this leads to divergent transitions, but in my mind it seems like the gradient of the parameter space in that region would

be extremely steep? Maybe you have a better intuition for what is happening. The problem is solved with higher $\texttt{adapt}_d eltaandsmaller$