**Assignment 4 – Exercise 3**

**John Hopkins University – Computational Modeling for Policy and Security Analysis**

In the Butterfly model the butterflies (turtles) are programmed to move 1 space per turn, either in a random direction or to its highest neighboring patch. The odds that a butterfly moves to the highest patch (versus moving randomly) is set at the beginning of the model in variable *q*. This movement algorithm makes the movement of the butterflies either extremely random, or too deterministic; the butterflies either move around completely randomly in models with very low *q* values, or seem to hover around the top of the hill nearest to the patch the butterflies start. This feels unnatural – the butterflies should show some pattern to their movement (i.e. generally moving to higher ground), while also showing a greater variety of movement (i.e. not only moving towards the nearest high point). I don’t know much about the movement of butterflies, but I imagine that they move for reasons other than elevation. For example, perhaps they tend to migrate from hill to hill over time, or perhaps they tend to roam in groups/herds. Another factor that could be making the movement of the butterflies in the model appear unnatural is the world in which the butterflies exist. The butterflies exist in a world with 4 hills that perfectly slope up – on all sides of every hill the patches rise towards the center of the hill. There are no false summits, there isn’t even variation in slope from hill side to hill side. This landscape may prevent wandering in the butterflies, based on the rules that have been supplied.

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After adding some noise to patch elevation, the butterflies move similarly to how they moved in the original model, except for that there appears to be a bit more randomness. Instead of heading straight-up the nearest hill, butterflies occasionally take longer, more winding paths up the hill. I imagine this is due to the terrain being a bit more difficult to navigate – the fastest way to the summit isn’t necessarily by moving to the highest neighboring area. Adding in this noise clarified the role of the landscape in the movement of the butterflies, it became more clear that the unnatural landscape played a role in the unnatural movement of the butterflies.