HW#2 1D spatial models using TMB

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Simulating Fish growth rates

We believe that fish growth patterns follow a similar patterns to that described by the von Bertalanffy growth curve

$$\hat{l}(a) = l_\infty - (l_\infty - l_0)exp(-ka)$$
$$l(a) \sim \mathcal{N}(\hat{l}(a), \sigma_l)$$

Where a is the age of the fish, l_∞ is the maximum length of a fish, l_{0} is the age of a fish at birth, k is the growth rate of the fish along the curve, and $l(a)$ is the observed length of a fish given its age. In addition l_∞ varies along the coastline with a general trend and via some unobserved spatial variation due to unmeasured environmental factors.

Modeling unobserved l_∞

I order to predict l_∞ which is unobserved we will use observed fish lengths in order to estimate the value. We assume that l_∞ follows a 1-D spatial process described be either

(1) $l_\infty \sim \mathcal{N}(\beta_0, \Sigma)$

or

(2) $l_\infty \sim \mathcal{N}(\beta_0 + \beta_1 s, \Sigma)$

Where β_0 is an intercept term and β_1 is the spatial trend across the coastline. Σ is characterized by two parameters ρ and σ_p which capture both the pointwise variation and the geostatistical range.

Simulation process

1000 observations of fish along the coast were simulated using a Random Gaussian field in order to simulate geospatial random error to which weights were then applied via an intercept and location (β_0 and β_1). From this $\hat{l}(a)$ was calculated using a distribution of ges that resemble a fish mortality and population patterns. $l(a)$ was drawn from a normal distribution with mean $\hat{l}(a)$ and standard deviation σ_l. In the estimation process we will use simulated values of $l(a)$ in order to try and recover the true values of l_∞ that were used in order to generate those values. This process was repeated 100 times for validation.

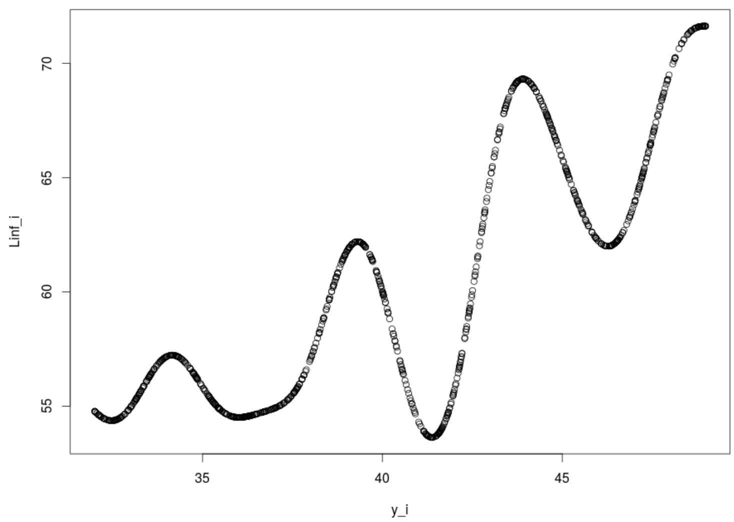
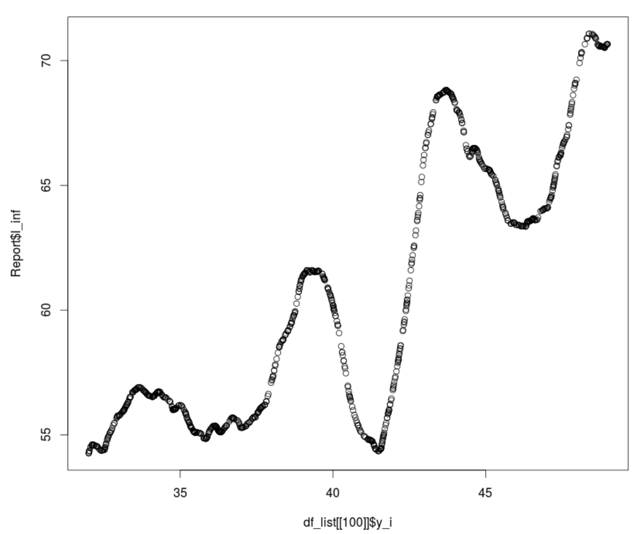


Figure 1: Simulated values of l_∞

Evaluation

RMSE was used to evaluate the two models. Estimated values with model (2).



When using covariates to inform the model for estimates of l_∞ the model was able to better recover l_∞ when the model was able to successfully converge. Both models had difficulty converging in some positions which may have to do with the simulation process not directly resembling the simulation process. This was true even when applying an equidistant AR model. This seems like it my be because the model simulation produces greater uncertainty farther away from the origin. In future simulations it may be advantages to explicitly write out the simulation.