Spatial data analyis of Parana State's average rainfall

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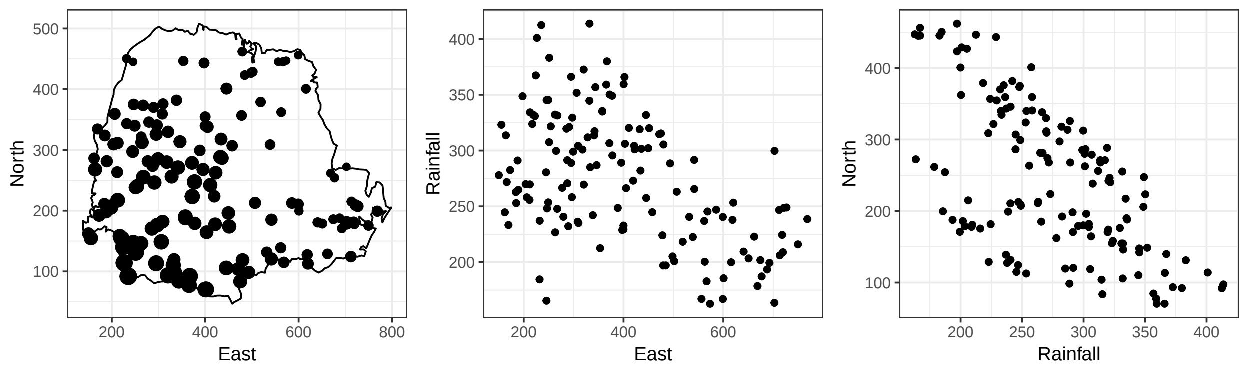
Introduction

Average rainfall over different years for the period May-June (dry-season) was collected at 143 recording stations located at different places in Parana State, Brasil. Below is the graphical analysis of the rainfall data. From data vs X coord scatter plot, we can infer that as we move to the eastern parts of state, average rainfall decreases. From Y coord vs data scatter plot, we can infer that as we move to the northern parts of state, average rainfall decreases. Rainfall is heavier in south-western parts compared to north-eastern parts.



Regression Analysis

A linear regression model was fit with rainfall as response and distance along east direction, distance along north direction and their interaction as explanatory variables.

$$rainfall = \beta_0 + \beta_1 x_E + \beta_2 x_N + \beta_3(x_E * x_N) + \epsilon$$

Below are the co-efficients and the p values indicating their significance.

	Estimate	Std. Error	t value	Pr(>|t|)
(Intercept)	513.4656578	19.1235307	26.849940	0.00e+00
east	-0.3682981	0.0430737	-8.550411	0.00e+00
north	-0.6765767	0.0764779	-8.846690	0.00e+00
east:north	0.0007568	0.0001769	4.278689	3.48e-05

As inferred from the plot, east and north co-efficients are significant and negative. Surprisingly interaction effect is positive yet negligibly small.

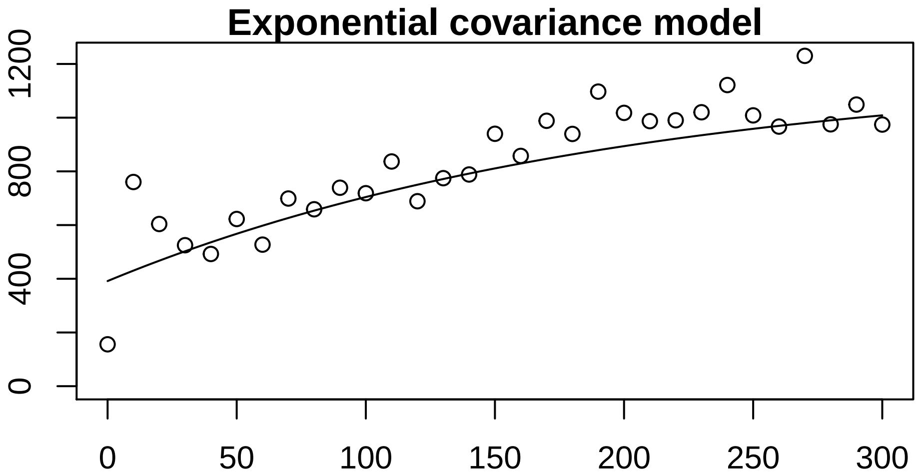
Spatial Analysis

As location paramaters are significant predictors of rainfall, exponential covaraince function of the form given below was fit to the spatial data.

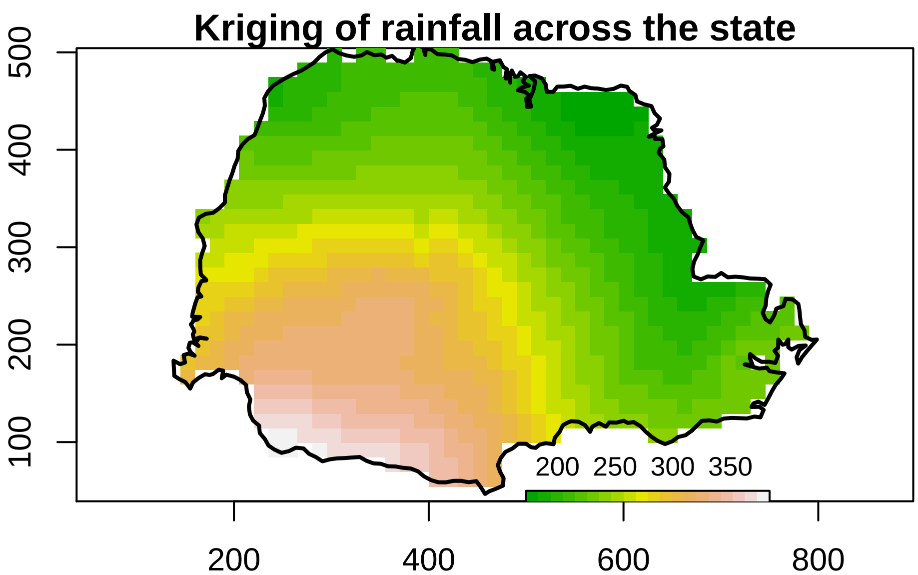
$$C(\mathbf{x}, \mathbf{x}+h) = \tau^2 + \sigma^2 e^{-\lambda h}$$

Coefficients	Estimates
tau-sq	391.56
sigma-sq	793.17
lambda	0.01

The estimators for the covariance function are calculated using MLE which are given in the above table. Below is the plot of exponential covariance model fitted on the spatial variance.



This exponential covaraince function was used for kriging across the state. Predicted values of average rainfall along the state is plotted below.



Conclusion

Dataset has 143 entries of average rainfall across the state. Initally a linear regression model helped us to infer that location parameters are significant predictors of rainfall. This analysis was extended by employing spatial statistics. Exponential covariance was a good fit to explain the spatial covariance. Finally kriging was applied to predict the rainfall across the state.