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Functional Modeling of Iranian Precipitation Based on Temperature and Humidity

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Extended Abstract. Functional Data Analysis (FDA) has recently made considerable progress because of easier access to the data that are essentially in the form of curves. Modeling of Iranian precipitation based on temperature and humidity with considering the essential nature of such phenomena that are continuous functions of time has not been done properly. The corresponding data are generally collected daily or monthly (discretely). However, if one treats those data as multivariate observations and analyzes by multivariate methods, it may cause some problems such as infinite number of solutions for normal equations in regression.

In regard to the fact that the original discrete data must be firstly converted to continuous functions, we usually use "basis function methods" for dimension reduction of the data due to its simplicity. In this article, problems arising from using multiple regression methods instead of applying functional regression approaches are discussed.

We have treated a real dataset that was collected from 102 Iranian weather stations in 2006. The dataset contains measurements related to the three phenomena; temperature, humidity and precipitation. For each station, we have 12 points corresponding to the monthly mean of each phenomenon. Then we have fitted a Fourier series with 13 terms to the orginal data, converting them to 102 continuous curves. After that, we have estimated coefficients of a functional linear regression in which there is only one independent variable (either temperature or relative humidity) and the response variable (logarithm of the total precipitation) is scalar. When using temperature ($\boldsymbol{X}(t)$) to predict the total amount of the precipitation of

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the year, we have constructed a simple functional regression model with $R^2 = 0.76$. Instead of temperature, the independent variable can also be taken as humidity that is essentially a function of time. In this case, we have obtained $R^2 = 0.68$. However, when entering the both variables (temperature and humidity) as independent variables, R^2 is increased to 0.86, meaning that the corresponding model represents the data better, compared to the previous models. Then, we extend the model by considering a functional response variable (logarithm of precipitation), and one of the two functional independent variables, and again estimated its coefficients. In this case, we have computed squared correlation measure (RSQ) for each model. When entering the both functional independent variables simultaneously, we have found that the amount of RSQ is increased. This means that predicting precipitation based on both temperature and humidity is more accurate than when we only consider one of them. At each stage, we have assessed the corresponding models and enterpreted the results.

Keywords. functional data analysis; functional regression; smoothing; basis functions.

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