CS60074: Advanced Machine Learning

Coding Assignment 1: Gaussian Process Regression

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Method

We observe the data $f(x)$ and fit it to a 3 degree polynomial to form an appropriate mean function. This is $m(x) = a_0x^3 + a_1x^2 + a_2x + a_3$. We subsequently then obtain $y(x) = f(x) - m(x)$, which we use as the zero-mean data, upon which we perform Gaussian Process Regression. We use the SE (Squared Exponential) Kernel Function, which is as follows:

$$k(x, x') = \sigma_f^2 e^{-\frac{(x-x')^2}{2l^2}}$$

Here, σ_f is the mean of $f(x)$ and l is a hyperparameter, which we tune using grid search (we find $l = 9$ works well for the given data).
We obtain y^* from GP regression using the missing data values, x^* and find the predictions by simply adding that to the mean function values. Formally speaking, $f'(x^*) = m(x^*) + y^*$ where f' is the prediction function.

Metrics and Plots

It is difficult to obtain accuracy in this problem setting since we obtain data for points where data does not exist. A qualitative assessment can however be made by looking at the obtained plots, where it is very easy to see that the Gaussian Process Regression captures the difference between the data $f(x)$ and the mean function $m(x)$ very well. This plot is attached below:

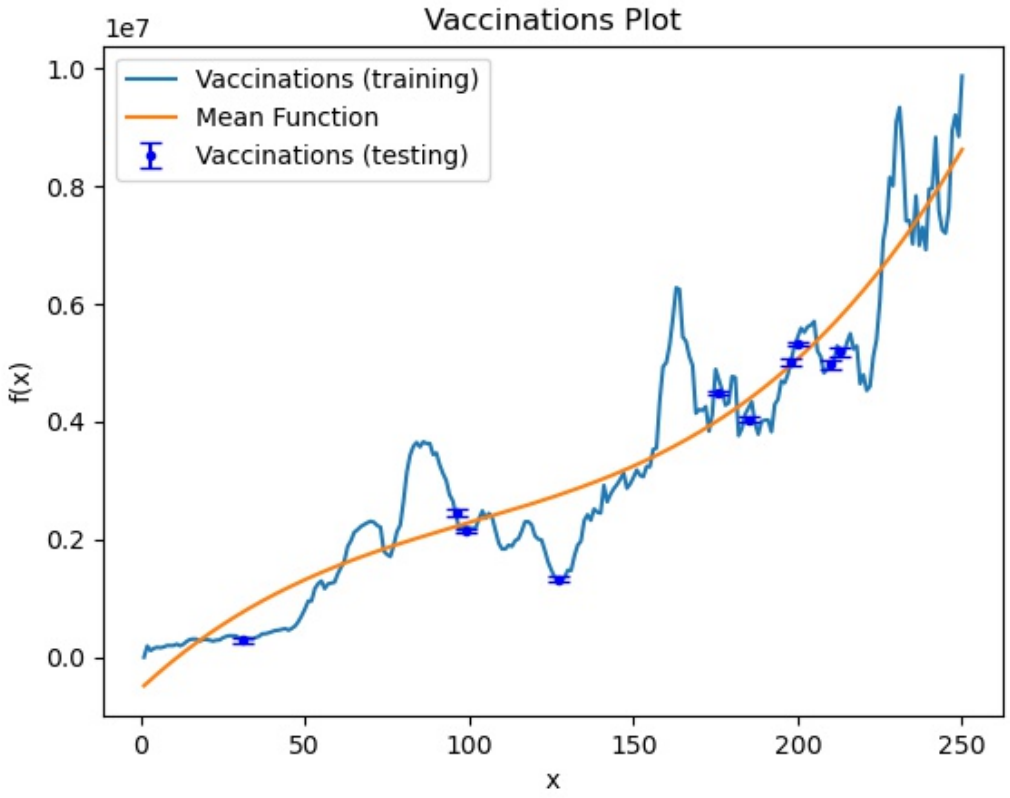

Fig. 1: Training, testing and mean function plots for GP Regression