Nonparametric Noise models for the Gaussian Process

Ulrich Paquet ULRIPA@MICROSOFT.COM
Microsoft Research, Cambridge

Jurgen Van Gael JURGEN@RANGESPAN.COM
Rangespan Ltd., B131 MacMillan House, Paddington Station, London W2 1FT, UK

Abstract

Notes while developing a Gaussian Process with nonparametric noise model.

1. Introduction

It is sometimes really hard to tell what noise model we want to use for a GP. A specific example is quantile regression for product demand forecasting. We've got an underlying trend, perhaps with cyclical component, which we can easily model with a GP by encoding prior knowledge in the covariance matrix. Unfortunately sales data might have spike and other irregularities which make choosing a noise model quite tricky. One option is to use a robust noise model like student-t or Laplace. In this work, we learn a noise model by using a non-parametric mixture of Gaussians.

2. Model

Imagine we have a time series with observations y_t at times x_t with $t \in [0, T]$. We model this data by assuming a latent Gaussian process

$$\boldsymbol{f} \sim \mathcal{GP}\left(0, \boldsymbol{K}(\boldsymbol{x}, \boldsymbol{x})\right) \tag{1}$$

We model the noise as a non-parametric mixture model using the Dirichlet process. Let

$$\boldsymbol{G} \sim \mathcal{DP}\left(\alpha, H\right) \tag{2}$$

be a Dirichlet process with concentration parameter α and base measure H. For each time t we introduce a noise variable $\epsilon_t \sim G$. We then model the observation $y_t = \boldsymbol{f}(x_t) + \epsilon_t$.

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3. Inference

We can perform inference in this model using a collapsed Gibbs sampler. In order to work with the CRP representation of the Dirichlet process we introduce a new variable z_t which will represent CRP partition that datapoint t belongs to.

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Please see below for details on each of these items.

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ps2pdf paper.ps

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We will continue the ICML tradition in which the authors are given the option of providing a short reaction to the initial reviews. These reactions will be taken into account in the discussion among the reviewers and area chairs.

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The footnote, "Preliminary work. Under review by the International Conference on Machine Learning (ICML). Do not distribute." must be modified to "Appearing in *Proceedings of the 29th International Conference on Machine Learning*, Edinburgh, Scotland, UK, 2012. Copyright 2012 by the author(s)/owner(s)."

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Section headings should be numbered, flush left, and set in 11 pt bold type with the content words capitalized. Leave 0.25 inches of space before the heading and 0.15 inches after the heading.

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Label all distinct components of each figure. If the figure takes the form of a graph, then give a name for each axis and include a legend that briefly describes each curve. Do not include a title inside the figure; instead, the caption should serve this function.

Number figures sequentially, placing the figure number and caption *after* the graphics, with at least 0.1 inches of space before the caption and 0.1 inches after it, as in Figure **??**. The figure caption should be set in 9 point type and centered unless it runs two or more lines, in which case it should be flush left. You may float figures to the top or bottom of a column, and you may set wide figures across both columns (use the environment `figure*` in LaTeX), but always place two-column figures at the top or bottom of the page.

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[2] Multiple footnotes can appear in each column, in the same order as they appear in the text, but spread them across columns and pages if possible.

Algorithm 1 Bubble Sort

Input: data x_i, size m
repeat
  Initialize $noChange = true$.
  for $i = 1$ **to** $m - 1$ **do**
    if $x_i > x_{i+1}$ **then**
      Swap x_i and x_{i+1}
      $noChange = false$
    end if
  end for
until $noChange$ is $true$

Table 1. Classification accuracies for naive Bayes and flexible Bayes on various data sets.

Data set	Naive	Flexible	Better?
Breast	95.9± 0.2	96.7± 0.2	$\surd$
Cleveland	83.3± 0.6	80.0± 0.6	$\times$
Glass2	61.9± 1.4	83.8± 0.7	$\surd$
Credit	74.8± 0.5	78.3± 0.6	
Horse	73.3± 0.9	69.7± 1.0	$\times$
Meta	67.1± 0.6	76.5± 0.5	$\surd$
Pima	75.1± 0.6	73.9± 0.5	
Vehicle	44.9± 0.6	61.5± 0.4	$\surd$

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Tables contain textual material that can be typeset, as contrasted with figures, which contain graphical material that must be drawn. Specify the contents of each row and column in the table's topmost row. Again, you may float tables to a column's top or bottom, and set wide tables across both columns, but place two-column tables at the top or bottom of the page.

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