Modern Gaussian Processes: Scalable Inference and Novel Applications

(Part I-a) Introduction

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Suggested Readings & Tutorial Website

Gaussian Processes for Machine Learning

Carl E. Rasmussen and Christopher K. I. Williams, 2006

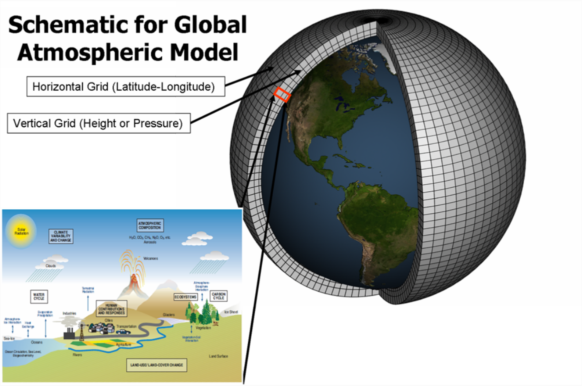
Pattern Recognition and Machine Learning

Christopher Bishop, 2006

Tutorial webpage

`https://ebonilla.github.io/gaussianprocesses`

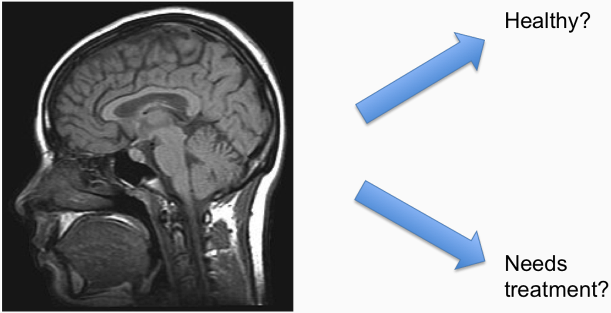
- Climate modeling



Kennedy and O'Hagan, *RSS-B*, 2001

Motivation

- Classification and progression modeling of neurodegenerative diseases



Filippone et al., *AoAS*, 2012

A Unified Framework

A model might be expensive to simulate/inaccurate

- Emulate model/discrepancy using a surrogate

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Quantification of Uncertainty

- Bayesian Neural Nets
- Gaussian Processes

Refresher on Probabilities

Consider two continuous random variables x and y

- Sum rule:

$$p(x) = \int p(x, y) dy$$

- Product rule:

$$p(x, y) = p(x|y)p(y) = p(y|x)p(x)$$

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- Sum rule:
$$p(x) = \int p(x, y) dy$$
- Product rule:
$$p(x, y) = p(x|y)p(y) = p(y|x)p(x)$$
- Bayes' rule:
$$p(y|x) = \frac{p(x|y)p(y)}{p(x)}$$
- NOTE: Bayes' rule is a direct consequence of the product rule

This Tutorial: Outline

1. Preamble [MF]
   - Introduction
   - Definition of Gaussian Processes
2. Approximations
   - Model Approximations [MF]

     $\Longrightarrow$ Break $\Longleftarrow$
   - Inference [EVB]
3. Applications, Challenges & Opportunities [EVB]
4. Theory and Code [MF]