Notes on Gaussian Processes

Compiled by D.Gueorguiev, 12/7/2024

# Introductory Notes

## Gaussian Models

The PDF of an MVN in dimensions is defined by the following:

(1)

where is the mean vector , and is the covariance matrix.

is known as the *precision matrix* or *concentration matrix*. The normalization constant ensures that the pdf integrates to 1.

A full covariance

The expression inside the exponent is the Mahalanobis distance between a data vector and the mean vector .

## Gaussian Processes (GP)

A Gaussian Process is a Gaussian distribution over functions:

## Noiseless Gaussian Process Regression

We observe a training set where

Given the test set of size , we want to predict the function outputs .

where is matrix, is matrix, and is

Here

# Appendix

## Covariance and Correlation

Covariance between two r.v.’s and measures the degree to which X and Y are related. Covariance is defined as:

# References

[1] [Gaussian Processes, Lecture by Nando Freitas, Feb 5th, 2013, UBC course CPSC 540-2013](https://youtu.be/MfHKW5z-OOA?si=QgoG1JPk40GsiXEI)

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[3] [Introduction to Gaussian Processes part 1: Bayesian Linear Regression, Lecture by Stefan Harmeling, TU Dortmund, Jan 9th, 2023](https://youtu.be/148EUutsU8Q?si=Quh1V_pPAAJzvfMw)

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[5] [Introduction to Gaussian Processes part 3: Kernel Design, Model Selection, GP Classification, Laplace Approximation, Lecture by Stefan Harmeling, TU Dortmund, Jan 16th, 2023](https://youtu.be/LFu7DAJcGKI?si=1hxx01IlX4ssJNBg)

[6] [Machine Learning Tutorial at Imperial College London: Gaussian Processes, Richard Turner, U of Cambridge, Nov 23th, 2016](https://youtu.be/92-98SYOdlY?si=K6cMS8998JFbpMi9)

[7] [Machine Learning: Probabilistic Perspective, Kevin P. Murphy, 2012](https://github.com/dimitarpg13/probabilistic_machine_learning/blob/main/books/MachineLearningProbabilisticPerspective.pdf)