September 9, 2025

1 Introduction

Naïve Bayes NB

$$p(y \mid \mathbf{x}) \propto p(y) \prod_{j=1}^{d} p(x_j \mid y), \tag{1}$$

y $\mathbf{x} = (x_1, \ldots, x_d)$ NB

2 Theory and Formulas

Gaussian NB $c \in \{1, \ldots, C\}$ j

$$x_j \mid y = c \ \sim\ \mathcal{N}(\mu_{c,j},\, \sigma^2_{c,j}). \tag{2}$$

$p(\mathbf{x} \mid y = c) = \prod_j \mathcal{N}(x_j\,;\, \mu_{c,j}, \sigma^2_{c,j})$ $p(y = c)$ ( )

$$\begin{aligned} \log p(y = c \mid \mathbf{x}) &\propto \log p(y = c) + \sum_{j=1}^{d} \log \mathcal{N}(x_j\,;\, \mu_{c,j}, \sigma^2_{c,j}) \qquad (3) \\ &\propto \log p(y = c) - \sum_{j=1}^{d} \Big[\tfrac{1}{2} \log(2\pi\sigma^2_{c,j}) + \tfrac{(x_j - \mu_{c,j})^2}{2\sigma^2_{c,j}} \Big]. \qquad (4) \end{aligned}$$

$\hat{y} = \arg\max_c \log p(y = c \mid \mathbf{x})$

Gaussian NB / Multinomial/Bernoulli NB

3 Applications and Tips

-
- Gaussian NB TF-IDF Multinomial NB
-
-
- /

4 Python Practice

`figures/`

Listing 1:

```
#
python gen_naive_bayes_figures.py
```

5 Result

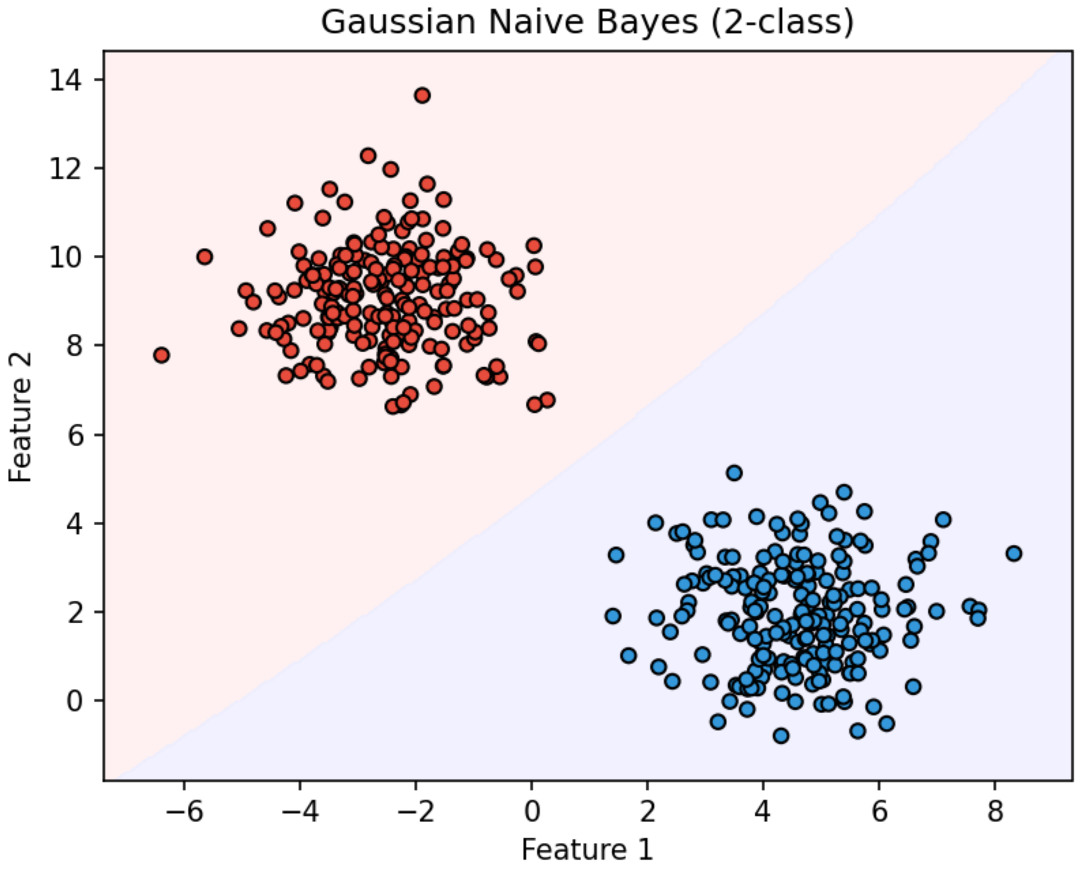

Figure 1: Gaussian NB

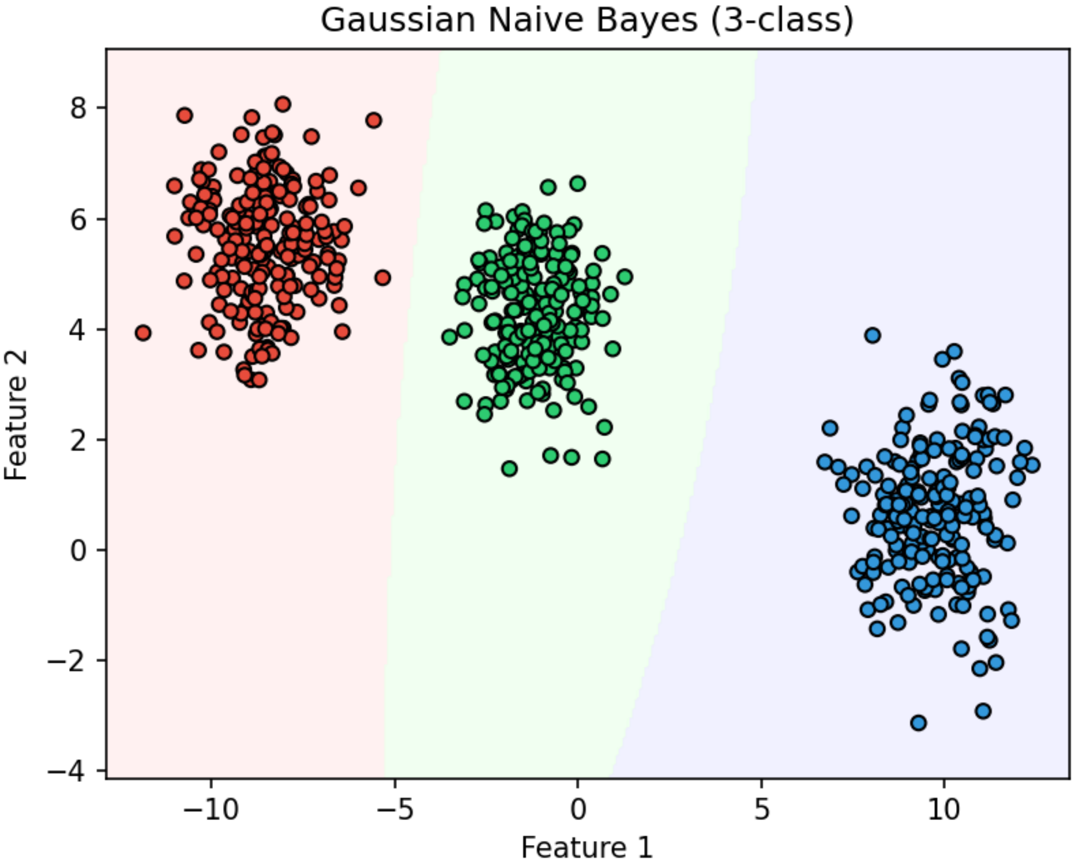

Figure 2: Gaussian NB

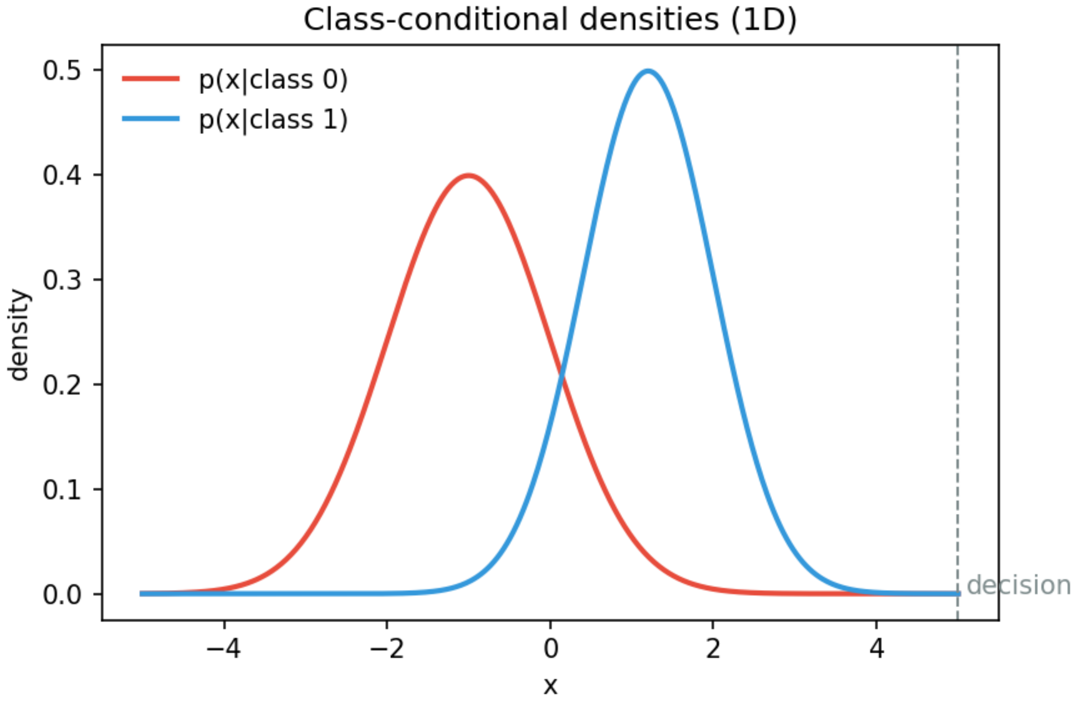
Class-conditional densities (1D)
p(x|class 0)
p(x|class 1)
decision
density
0.0
0.1
0.2
0.3
0.4
0.5
x
−4
−2
0
2
4

Figure 3:

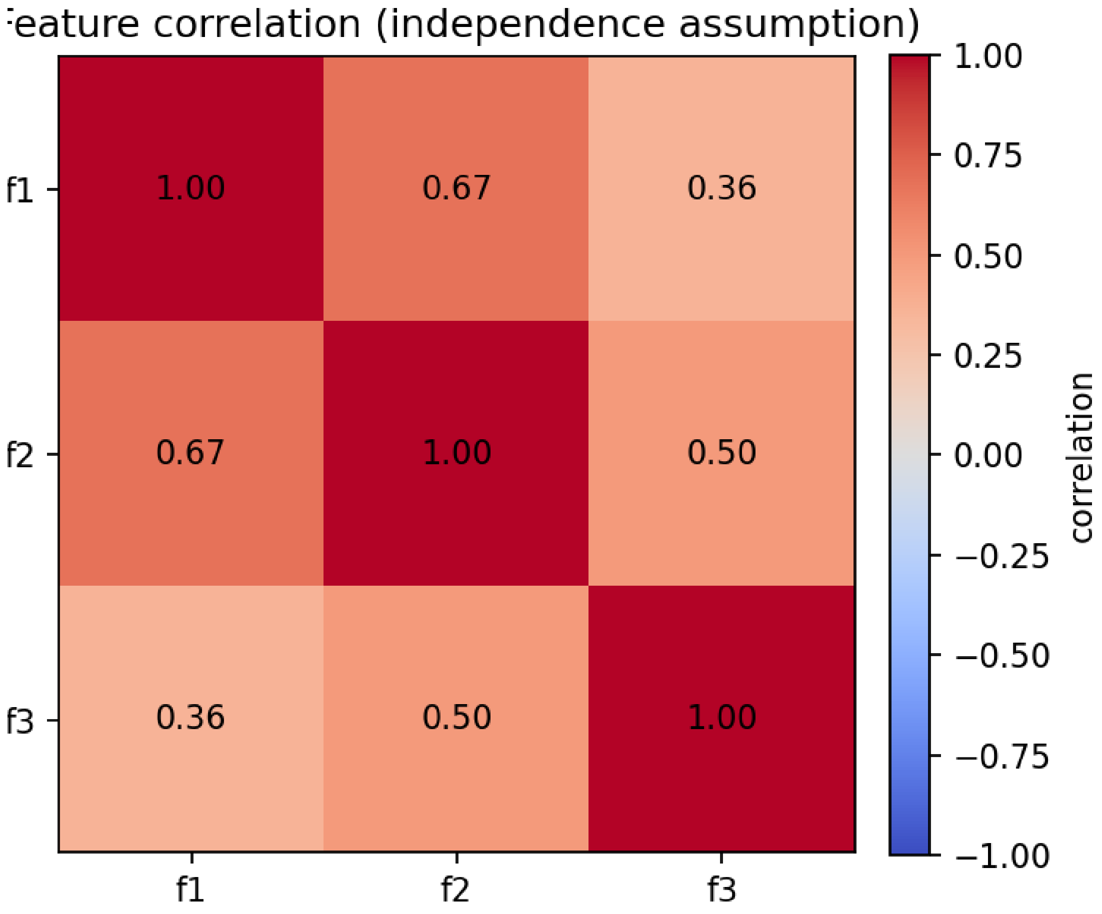

Figure 4:

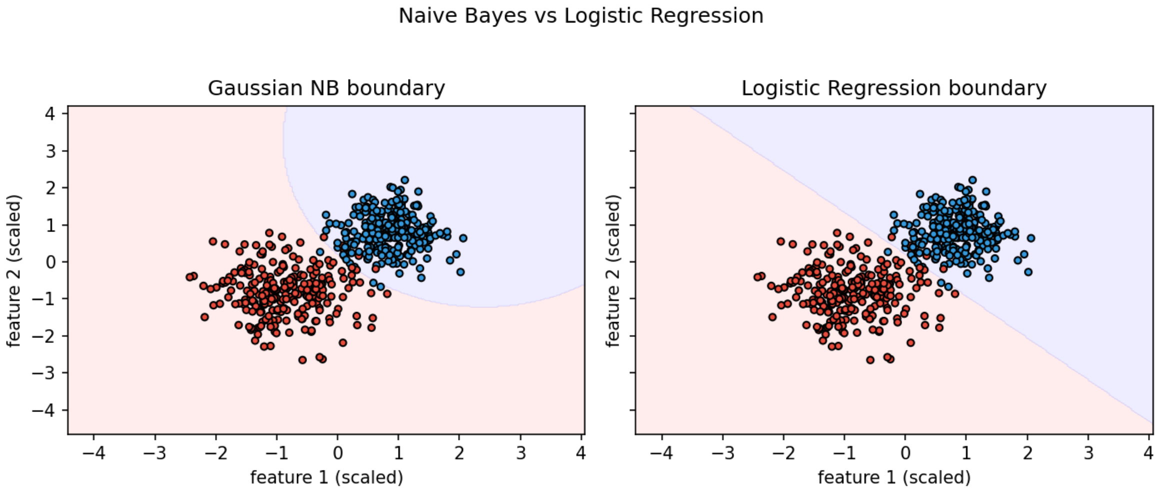

Figure 5: Gaussian NB

6 Summary