

Imagine you work for a bank and you want to predict whether a loan applicant will default on their loan or not based on some demographic and financial data. Here is a sample dataset containing 10 loan applicants and whether they defaulted on their loan or not:

Applicant ID	Age	Income	Education Level	Defaulted
1	25 20-29	20,000 <20000	High School	No
2	35 30-39	50,000 40000-50000	Bachelor's	No
3	45 40-49	80,000 60000-80000	Master's	No
4	28 20-29	22,000 20001-30000	High School	No
5	32 30-39	45,000 40000-50000	Bachelor's	Yes
6	46 40-49	70,000 60000-70000	Master's	No
7	24 20-29	18,000 <20000	High School	Yes
8	38 30-39	60,000 50000-70000	Bachelor's	No
9	32 30-39	48,000 40000-50000	Bachelor's	No
10	29 20-29	25,000 <20001-30000	High School	Yes

Applicant ID	Age	Income	Education Level	Defaulted
11	31 30-39	55,000 40000-50000	Bachelor's	?

In this example, we have a new applicant who is 31 years old, has an annual income of \$55,000, and has a Bachelor's degree. The question mark in the Defaulted column indicates that we do not know whether this applicant will default on their loan or not. We can use our Naive Bayes classifier to predict the value of the Defaulted column for this new applicant based on the values of the other columns.

Likehood  $P(\text{age} = 31, \text{income} = 55,000, \text{education level} = \text{Bachelor's})$

$$\text{Prior } P(\text{Defaulted}) = \frac{3}{10} \text{ (yes)}$$

$$P(\text{age} = 30-39 | \text{Defaulted}) \times P(\text{income} 40000-50000 | \text{Defaulted}) \times P(\text{education level} = \text{Bachelor's} | \text{Defaulted}) \\ \frac{1}{3} \quad \frac{1}{3} \quad \frac{1}{3} \\ 0.0363 \times 0.3 = 0.1089$$

$$\text{Prior } P(\text{Defaulted}) = \frac{7}{10} \text{ (no)}$$

$$P(\text{age} = 30-39 | \text{Defaulted}) \times P(\text{income} 40000-50000 | \text{Defaulted}) \times P(\text{education level} = \text{Bachelor's} | \text{Defaulted}) \\ \frac{3}{7} \quad \frac{1}{7} \quad \frac{3}{7} \\ 0.42 \quad 0.29 \quad 0.42 = 0.42 \times 0.29 = 0.343$$

now no more 0.34 than min