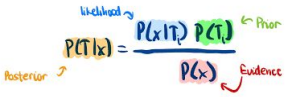
# Classificação: Naive Bayes



# Naive Bayes: Bayes Theorem.

$$P(A|B) = \frac{P(B|A)P(A)}{P(B)}$$

# ML: Classificação - Bayes

| quake | flood | hurricane | wildfire | loss |
|---|---|---|---|---|
| 8 | 0 | 0 | 1 | **yes** |
| 0 | 0 | 4 | 0 | **yes** |
| 8 | 0 | 4 | 0.7 | **no** |
| 0 | 0 | 0 | 1 | **yes** |
| 8 | 0 | 4 | 1 | **yes** |
| 5 | 0 | 2 | 1 | **yes** |
| 0 | 0 | 4 | 0.7 | **yes** |
| 0 | 0 | 2 | 0 | **no** |
| 0 | 5 | 2 | 1 | **yes** |
| 0 | 10 | 2 | 1 | **no** |
| 5 | 0 | 4 | 0.7 | **yes** |
| 8 | 5 | 4 | 0 | **yes** |
| 0 | 10 | 0 | 0.7 | **yes** |
| 0 | 0 | 2 | 0.7 | **yes** |
| 0 | 5 | 2 | 0 | **yes** |

# ML: Classificação - Bayes

| quake | flood | hurricane | wildfire | loss |
|---|---|---|---|---|
| 8 | 0 | 0 | 1 | **yes** ✅ |
| 0 | 0 | 4 | 0 | **yes** |
| 8 | 0 | 4 | 0.7 | **no** |
| 0 | 0 | 0 | 1 | **yes** |
| 8 | 0 | 4 | 1 | **yes** |
| 5 | 0 | 2 | 1 | **yes** |
| 0 | 0 | 4 | 0.7 | **yes** |
| 0 | 0 | 2 | 0 | **no** |
| 0 | 5 | 2 | 1 | **yes** |
| 0 | 10 | 2 | 1 | **no** |
| 5 | 0 | 4 | 0.7 | **yes** |
| 8 | 5 | 4 | 0 | **yes** |
| 0 | 10 | 0 | 0.7 | **yes** |
| 0 | 0 | 2 | 0.7 | **yes** |
| 0 | 5 | 2 | 0 | **yes** |

# ML: Classificação - Bayes

| quake | flood | hurricane | wildfire | loss |
|---|---|---|---|---|
| 8 | 0 | 0 | 1 | **yes** ✅ |
| 0 | 0 | 4 | 0 | **yes** ✅ |
| 8 | 0 | 4 | 0.7 | **no** |
| 0 | 0 | 0 | 1 | **yes** |
| 8 | 0 | 4 | 1 | **yes** |
| 5 | 0 | 2 | 1 | **yes** |
| 0 | 0 | 4 | 0.7 | **yes** |
| 0 | 0 | 2 | 0 | **no** |
| 0 | 5 | 2 | 1 | **yes** |
| 0 | 10 | 2 | 1 | **no** |
| 5 | 0 | 4 | 0.7 | **yes** |
| 8 | 5 | 4 | 0 | **yes** |
| 0 | 10 | 0 | 0.7 | **yes** |
| 0 | 0 | 2 | 0.7 | **yes** |
| 0 | 5 | 2 | 0 | **yes** |

# ML: Classificação - Bayes

| quake | flood | hurricane | wildfire | loss |
|---|---|---|---|---|
| 8 | 0 | 0 | 1 | **yes** ✅ |
| 0 | 0 | 4 | 0 | **yes** ✅ |
| 8 | 0 | 4 | 0.7 | **no** |
| 0 | 0 | 0 | 1 | **yes** ✅ |
| 8 | 0 | 4 | 1 | **yes** |
| 5 | 0 | 2 | 1 | **yes** |
| 0 | 0 | 4 | 0.7 | **yes** |
| 0 | 0 | 2 | 0 | **no** |
| 0 | 5 | 2 | 1 | **yes** |
| 0 | 10 | 2 | 1 | **no** |
| 5 | 0 | 4 | 0.7 | **yes** |
| 8 | 5 | 4 | 0 | **yes** |
| 0 | 10 | 0 | 0.7 | **yes** |
| 0 | 0 | 2 | 0.7 | **yes** |
| 0 | 5 | 2 | 0 | **yes** |

# ML: Classificação - Bayes

| quake | flood | hurricane | wildfire | loss |
|---|---|---|---|---|
| 8 | 0 | 0 | 1 | **yes** ✅ |
| 0 | 0 | 4 | 0 | **yes** ✅ |
| 8 | 0 | 4 | 0.7 | **no** |
| 0 | 0 | 0 | 1 | **yes** ✅ |
| 8 | 0 | 4 | 1 | **yes** ✅ |
| 5 | 0 | 2 | 1 | **yes** |
| 0 | 0 | 4 | 0.7 | **yes** |
| 0 | 0 | 2 | 0 | **no** |
| 0 | 5 | 2 | 1 | **yes** |
| 0 | 10 | 2 | 1 | **no** |
| 5 | 0 | 4 | 0.7 | **yes** |
| 8 | 5 | 4 | 0 | **yes** |
| 0 | 10 | 0 | 0.7 | **yes** |
| 0 | 0 | 2 | 0.7 | **yes** |
| 0 | 5 | 2 | 0 | **yes** |

# ML: Classificação - Bayes

| quake | flood | hurricane | wildfire | loss |
|---|---|---|---|---|
| 8 | 0 | 0 | 1 | **yes** ✅ |
| 0 | 0 | 4 | 0 | **yes** ✅ |
| 8 | 0 | 4 | 0.7 | **no** |
| 0 | 0 | 0 | 1 | **yes** ✅ |
| 8 | 0 | 4 | 1 | **yes** ✅ |
| 5 | 0 | 2 | 1 | **yes** ✅ |
| 0 | 0 | 4 | 0.7 | **yes** |
| 0 | 0 | 2 | 0 | **no** |
| 0 | 5 | 2 | 1 | **yes** |
| 0 | 10 | 2 | 1 | **no** |
| 5 | 0 | 4 | 0.7 | **yes** |
| 8 | 5 | 4 | 0 | **yes** |
| 0 | 10 | 0 | 0.7 | **yes** |
| 0 | 0 | 2 | 0.7 | **yes** |
| 0 | 5 | 2 | 0 | **yes** |

# ML: Classificação - Bayes

| quake | flood | hurricane | wildfire | loss |
|---|---|---|---|---|
| 8 | 0 | 0 | 1 | **yes** ✅ |
| 0 | 0 | 4 | 0 | **yes** ✅ |
| 8 | 0 | 4 | 0.7 | **no** |
| 0 | 0 | 0 | 1 | **yes** ✅ |
| 8 | 0 | 4 | 1 | **yes** ✅ |
| 5 | 0 | 2 | 1 | **yes** ✅ |
| 0 | 0 | 4 | 0.7 | **yes** ✅ |
| 0 | 0 | 2 | 0 | **no** |
| 0 | 5 | 2 | 1 | **yes** |
| 0 | 10 | 2 | 1 | **no** |
| 5 | 0 | 4 | 0.7 | **yes** |
| 8 | 5 | 4 | 0 | **yes** |
| 0 | 10 | 0 | 0.7 | **yes** |
| 0 | 0 | 2 | 0.7 | **yes** |
| 0 | 5 | 2 | 0 | **yes** |

# ML: Classificação - Bayes

| quake | flood | hurricane | wildfire | loss |
|---|---|---|---|---|
| 8 | 0 | 0 | 1 | **yes** ✅ |
| 0 | 0 | 4 | 0 | **yes** ✅ |
| 8 | 0 | 4 | 0.7 | **no** |
| 0 | 0 | 0 | 1 | **yes** ✅ |
| 8 | 0 | 4 | 1 | **yes** ✅ |
| 5 | 0 | 2 | 1 | **yes** ✅ |
| 0 | 0 | 4 | 0.7 | **yes** ✅ |
| 0 | 0 | 2 | 0 | **no** |
| 0 | 5 | 2 | 1 | **yes** ✅ |
| 0 | 10 | 2 | 1 | **no** |
| 5 | 0 | 4 | 0.7 | **yes** |
| 8 | 5 | 4 | 0 | **yes** |
| 0 | 10 | 0 | 0.7 | **yes** |
| 0 | 0 | 2 | 0.7 | **yes** |
| 0 | 5 | 2 | 0 | **yes** |

# ML: Classificação - Bayes

| quake | flood | hurricane | wildfire | loss |
|---|---|---|---|---|
| 8 | 0 | 0 | 1 | **yes** ✅ |
| 0 | 0 | 4 | 0 | **yes** ✅ |
| 8 | 0 | 4 | 0.7 | **no** |
| 0 | 0 | 0 | 1 | **yes** ✅ |
| 8 | 0 | 4 | 1 | **yes** ✅ |
| 5 | 0 | 2 | 1 | **yes** ✅ |
| 0 | 0 | 4 | 0.7 | **yes** ✅ |
| 0 | 0 | 2 | 0 | **no** |
| 0 | 5 | 2 | 1 | **yes** ✅ |
| 0 | 10 | 2 | 1 | **no** |
| 5 | 0 | 4 | 0.7 | **yes** ✅ |
| 8 | 5 | 4 | 0 | **yes** |
| 0 | 10 | 0 | 0.7 | **yes** |
| 0 | 0 | 2 | 0.7 | **yes** |
| 0 | 5 | 2 | 0 | **yes** |

# ML: Classificação - Bayes

| quake | flood | hurricane | wildfire | loss |
|---|---|---|---|---|
| 8 | 0 | 0 | 1 | **yes** ✅ |
| 0 | 0 | 4 | 0 | **yes** ✅ |
| 8 | 0 | 4 | 0.7 | **no** |
| 0 | 0 | 0 | 1 | **yes** ✅ |
| 8 | 0 | 4 | 1 | **yes** ✅ |
| 5 | 0 | 2 | 1 | **yes** ✅ |
| 0 | 0 | 4 | 0.7 | **yes** ✅ |
| 0 | 0 | 2 | 0 | **no** |
| 0 | 5 | 2 | 1 | **yes** ✅ |
| 0 | 10 | 2 | 1 | **no** |
| 5 | 0 | 4 | 0.7 | **yes** ✅ |
| 8 | 5 | 4 | 0 | **yes** ✅ |
| 0 | 10 | 0 | 0.7 | **yes** |
| 0 | 0 | 2 | 0.7 | **yes** |
| 0 | 5 | 2 | 0 | **yes** |

# ML: Classificação - Bayes

| quake | flood | hurricane | wildfire | loss |
|---|---|---|---|---|
| 8 | 0 | 0 | 1 | yes ✅ |
| 0 | 0 | 4 | 0 | yes ✅ |
| 8 | 0 | 4 | 0.7 | no |
| 0 | 0 | 0 | 1 | yes ✅ |
| 8 | 0 | 4 | 1 | yes ✅ |
| 5 | 0 | 2 | 1 | yes ✅ |
| 0 | 0 | 4 | 0.7 | yes ✅ |
| 0 | 0 | 2 | 0 | no |
| 0 | 5 | 2 | 1 | yes ✅ |
| 0 | 10 | 2 | 1 | no |
| 5 | 0 | 4 | 0.7 | yes ✅ |
| 8 | 5 | 4 | 0 | yes ✅ |
| 0 | 10 | 0 | 0.7 | yes ✅ |
| 0 | 0 | 2 | 0.7 | yes |
| 0 | 5 | 2 | 0 | yes |

# ML: Classificação - Bayes

| quake | flood | hurricane | wildfire | loss |
|---|---|---|---|---|
| 8 | 0 | 0 | 1 | **yes** ✅ |
| 0 | 0 | 4 | 0 | **yes** ✅ |
| 8 | 0 | 4 | 0.7 | **no** |
| 0 | 0 | 0 | 1 | **yes** ✅ |
| 8 | 0 | 4 | 1 | **yes** ✅ |
| 5 | 0 | 2 | 1 | **yes** ✅ |
| 0 | 0 | 4 | 0.7 | **yes** ✅ |
| 0 | 0 | 2 | 0 | **no** |
| 0 | 5 | 2 | 1 | **yes** ✅ |
| 0 | 10 | 2 | 1 | **no** |
| 5 | 0 | 4 | 0.7 | **yes** ✅ |
| 8 | 5 | 4 | 0 | **yes** ✅ |
| 0 | 10 | 0 | 0.7 | **yes** ✅ |
| 0 | 0 | 2 | 0.7 | **yes** ✅ |
| 0 | 5 | 2 | 0 | **yes** |

# ML: Classificação - Bayes

| quake | flood | hurricane | wildfire | loss |
|---|---|---|---|---|
| 8 | 0 | 0 | 1 | **yes** ✅ |
| 0 | 0 | 4 | 0 | **yes** ✅ |
| 8 | 0 | 4 | 0.7 | **no** |
| 0 | 0 | 0 | 1 | **yes** ✅ |
| 8 | 0 | 4 | 1 | **yes** ✅ |
| 5 | 0 | 2 | 1 | **yes** ✅ |
| 0 | 0 | 4 | 0.7 | **yes** ✅ |
| 0 | 0 | 2 | 0 | **no** |
| 0 | 5 | 2 | 1 | **yes** ✅ |
| 0 | 10 | 2 | 1 | **no** |
| 5 | 0 | 4 | 0.7 | **yes** ✅ |
| 8 | 5 | 4 | 0 | **yes** ✅ |
| 0 | 10 | 0 | 0.7 | **yes** ✅ |
| 0 | 0 | 2 | 0.7 | **yes** ✅ |
| 0 | 5 | 2 | 0 | **yes** ✅ |

# ML: Classificação - Bayes

| quake | flood | hurricane | wildfire | loss |
|---|---|---|---|---|
| 8 | 0 | 0 | 1 | yes ✅ |
| 0 | 0 | 4 | 0 | yes ✅ |
| 8 | 0 | 4 | 0.7 | no |
| 0 | 0 | 0 | 1 | yes ✅ |
| 8 | 0 | 4 | 1 | yes ✅ |
| 5 | 0 | 2 | 1 | yes ✅ |
| 0 | 0 | 4 | 0.7 | yes ✅ |
| 0 | 0 | 2 | 0 | no |
| 0 | 5 | 2 | 1 | yes ✅ |
| 0 | 10 | 2 | 1 | no |
| 5 | 0 | 4 | 0.7 | yes ✅ |
| 8 | 5 | 4 | 0 | yes ✅ |
| 0 | 10 | 0 | 0.7 | yes ✅ |
| 0 | 0 | 2 | 0.7 | yes ✅ |
| 0 | 5 | 2 | 0 | yes ✅ |

**12/15**

# ML: Classificação - Bayes

| quake | flood | hurricane | wildfire | loss |
|---|---|---|---|---|
| 8 | 0 | 0 | 1 | yes ✅ |
| 0 | 0 | 4 | 0 | yes ✅ |
| 8 | 0 | 4 | 0.7 | no ❌ |
| 0 | 0 | 0 | 1 | yes ✅ |
| 8 | 0 | 4 | 1 | yes ✅ |
| 5 | 0 | 2 | 1 | yes ✅ |
| 0 | 0 | 4 | 0.7 | yes ✅ |
| 0 | 0 | 2 | 0 | no |
| 0 | 5 | 2 | 1 | yes ✅ |
| 0 | 10 | 2 | 1 | no |
| 5 | 0 | 4 | 0.7 | yes ✅ |
| 8 | 5 | 4 | 0 | yes ✅ |
| 0 | 10 | 0 | 0.7 | yes ✅ |
| 0 | 0 | 2 | 0.7 | yes ✅ |
| 0 | 5 | 2 | 0 | yes ✅ |

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# ML: Classificação - Bayes

| quake | flood | hurricane | wildfire | loss |
|---|---|---|---|---|
| 8 | 0 | 0 | 1 | yes ✅ |
| 0 | 0 | 4 | 0 | yes ✅ |
| 8 | 0 | 4 | 0.7 | no ❌ |
| 0 | 0 | 0 | 1 | yes ✅ |
| 8 | 0 | 4 | 1 | yes ✅ |
| 5 | 0 | 2 | 1 | yes ✅ |
| 0 | 0 | 4 | 0.7 | yes ✅ |
| 0 | 0 | 2 | 0 | no ❌ |
| 0 | 5 | 2 | 1 | yes ✅ |
| 0 | 10 | 2 | 1 | no |
| 5 | 0 | 4 | 0.7 | yes ✅ |
| 8 | 5 | 4 | 0 | yes ✅ |
| 0 | 10 | 0 | 0.7 | yes ✅ |
| 0 | 0 | 2 | 0.7 | yes ✅ |
| 0 | 5 | 2 | 0 | yes ✅ |

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# ML: Classificação - Bayes

| quake | flood | hurricane | wildfire | loss |
|---|---|---|---|---|
| 8 | 0 | 0 | 1 | yes ✅ |
| 0 | 0 | 4 | 0 | yes ✅ |
| 8 | 0 | 4 | 0.7 | no ❌ |
| 0 | 0 | 0 | 1 | yes ✅ |
| 8 | 0 | 4 | 1 | yes ✅ |
| 5 | 0 | 2 | 1 | yes ✅ |
| 0 | 0 | 4 | 0.7 | yes ✅ |
| 0 | 0 | 2 | 0 | no ❌ |
| 0 | 5 | 2 | 1 | yes ✅ |
| 0 | 10 | 2 | 1 | no ❌ |
| 5 | 0 | 4 | 0.7 | yes ✅ |
| 8 | 5 | 4 | 0 | yes ✅ |
| 0 | 10 | 0 | 0.7 | yes ✅ |
| 0 | 0 | 2 | 0.7 | yes ✅ |
| 0 | 5 | 2 | 0 | yes ✅ |

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# ML: Classificação - Bayes

| quake | flood | hurricane | wildfire | loss |
|---|---|---|---|---|
| 8 | 0 | 0 | 1 | yes ✅ |
| 0 | 0 | 4 | 0 | yes ✅ |
| 8 | 0 | 4 | 0.7 | no ❌ |
| 0 | 0 | 0 | 1 | yes ✅ |
| 8 | 0 | 4 | 1 | yes ✅ |
| 5 | 0 | 2 | 1 | yes ✅ |
| 0 | 0 | 4 | 0.7 | yes ✅ |
| 0 | 0 | 2 | 0 | no ❌ |
| 0 | 5 | 2 | 1 | yes ✅ |
| 0 | 10 | 2 | 1 | no ❌ |
| 5 | 0 | 4 | 0.7 | yes ✅ |
| 8 | 5 | 4 | 0 | yes ✅ |
| 0 | 10 | 0 | 0.7 | yes ✅ |
| 0 | 0 | 2 | 0.7 | yes ✅ |
| 0 | 5 | 2 | 0 | yes ✅ |

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# ML: Classificação - Bayes

| | quake | | no | yes |
|---|---|---|---|---|
| *no quake (0)* | 2 | 7 | *2/3* | *7/12* |
| *level 5* | 0 | 2 | *0/3* | *2/12* |
| *level 8* | 1 | 3 | *1/3* | *3/12* |

# ML: Classificação - Bayes

| | quake | | no | yes |
|---|---|---|---|---|
| *no quake (0)* | 2 | 7 | *2/3* | *7/12* |
| *level 5* | 0 | 2 | *0/3* | *2/12* |
| *level 8* | 1 | 3 | *1/3* | *3/12* |

| | flood | | no | yes |
|---|---|---|---|---|
| *no flood (0)* | 2 | 8 | *2/3* | *8/12* |
| *mid level (5)* | 0 | 3 | *0/3* | *3/12* |
| *max level (10)* | 1 | 1 | *1/3* | *1/12* |

# ML: Classificação - Bayes

| | quake | | no | yes |
|---|---|---|---|---|
| *no quake (0)* | 2 | 7 | *2/3* | *7/12* |
| *level 5* | 0 | 2 | *0/3* | *2/12* |
| *level 8* | 1 | 3 | *1/3* | *3/12* |

| | hurricane | | no | yes |
|---|---|---|---|---|
| *no hurricane (0)* | 0 | 3 | *0/3* | *3/12* |
| *category 2* | 2 | 4 | *2/4* | *4/12* |
| *category 4* | 1 | 5 | *1/3* | *5/12* |

| | flood | | no | yes |
|---|---|---|---|---|
| *no flood (0)* | 2 | 8 | *2/3* | *8/12* |
| *mid level (5)* | 0 | 3 | *0/3* | *3/12* |
| *max level (10)* | 1 | 1 | *1/3* | *1/12* |

# ML: Classificação - Bayes

| | quake | | no | yes |
|---|---|---|---|---|
| no quake (0) | 2 | 7 | 2/3 | 7/12 |
| level 5 | 0 | 2 | 0/3 | 2/12 |
| level 8 | 1 | 3 | 1/3 | 3/12 |

| | hurricane | | no | yes |
|---|---|---|---|---|
| no hurricane (0) | 0 | 3 | 0/3 | 3/12 |
| category 2 | 2 | 4 | 2/4 | 4/12 |
| category 4 | 1 | 5 | 1/3 | 5/12 |

| | flood | | no | yes |
|---|---|---|---|---|
| no flood (0) | 2 | 8 | 2/3 | 8/12 |
| mid level (5) | 0 | 3 | 0/3 | 3/12 |
| max level (10) | 1 | 1 | 1/3 | 1/12 |

| | wildfire | | no | yes |
|---|---|---|---|---|
| no fire (0) | 1 | 3 | 1/3 | 3/12 |
| high (0.7) | 1 | 4 | 1/3 | 4/12 |
| extreme (1.0) | 1 | 5 | 1/3 | 5/12 |

# ML: Classificação - Bayes

| | quake | | no | yes |
|---|---|---|---|---|
| *no quake (0)* | 2 | 7 | *2/3* | *7/12* |
| *level 5* | 0 | 2 | *0/3* | *2/12* |
| *level 8* | 1 | 3 | *1/3* | *3/12* |

| | hurricane | | no | yes |
|---|---|---|---|---|
| *no hurricane (0)* | 0 | 3 | *0/3* | *3/12* |
| *category 2* | 2 | 4 | *2/4* | *4/12* |
| *category 4* | 1 | 5 | *1/3* | *5/12* |

| | flood | | no | yes |
|---|---|---|---|---|
| *no flood (0)* | 2 | 8 | *2/3* | *8/12* |
| *mid level (5)* | 0 | 3 | *0/3* | *3/12* |
| *max level (10)* | 1 | 1 | *1/3* | *1/12* |

| | wildfire | | no | yes |
|---|---|---|---|---|
| *no fire (0)* | 1 | 3 | *1/3* | *3/12* |
| *high (0.7)* | 1 | 4 | *1/3* | *4/12* |
| *extreme (1.0)* | 1 | 5 | *1/3* | *5/12* |

P(Quake level 8 | no) = ⅓

P(Flood max-level | no) = ⅓

P(Hurricane categ. 4 | no) = ⅓

P(Wildfire extreme | no ) = ⅓

**P(No sig. loss) = 3/15**

# ML: Classificação - Bayes

| | quake | | no | yes |
|---|---|---|---|---|
| *no quake (0)* | 2 | 7 | *2/3* | *7/12* |
| *level 5* | 0 | 2 | *0/3* | *2/12* |
| *level 8* | 1 | 3 | *1/3* | *3/12* |

| | hurricane | | no | yes |
|---|---|---|---|---|
| *no hurricane (0)* | 0 | 3 | *0/3* | *3/12* |
| *category 2* | 2 | 4 | *2/4* | *4/12* |
| *category 4* | 1 | 5 | *1/3* | *5/12* |

| | flood | | no | yes |
|---|---|---|---|---|
| *no flood (0)* | 2 | 8 | *2/3* | *8/12* |
| *mid level (5)* | 0 | 3 | *0/3* | *3/12* |
| *max level (10)* | 1 | 1 | *1/3* | *1/12* |

| | wildfire | | no | yes |
|---|---|---|---|---|
| *no fire (0)* | 1 | 3 | *1/3* | *3/12* |
| *high (0.7)* | 1 | 4 | *1/3* | *4/12* |
| *extreme (1.0)* | 1 | 5 | *1/3* | *5/12* |

P(Quake level 8 | no) = ⅓
P(Flood max-level | no) = ⅓
P(Hurricane categ. 4 | no) = ⅓
P(Wildfire extreme | no ) = ⅓
**P(No sig. loss) = 3/15**

P(Quake level 8 | yes) = 3/12
P(Flood max-level | yes) = 1/12
P(Hurricane categ. 4 | yes) = 5/12
P(Wildfire extreme | yes ) = 5/12
**P(Yes sig. loss) = 12/15**

# ML: Classificação - Bayes

P(Quake level 8 | no) = ⅓
P(Flood max-level | no) = ⅓
P(Hurricane categ. 4 | no) = ⅓
P(wildfire extreme | no ) = ⅓
**P(No sig. loss) = 3/15**

P(Quake level 8 | yes) = 3/12
P(Flood max-level | yes) = 1/12
P(Hurricane categ. 4 | yes) = 5/12
P(wildfire extreme | yes ) = 5/12
**P(Yes sig. loss) = 12/15**

P(Q^F^H^W | No ) x P(No)= ⅓ x ⅓ x ⅓ x ⅓ x 3/15 = 0.0025

# ML: Classificação - Bayes

P(Quake level 8 | no) = ⅓
P(Flood max-level | no) = ⅓
P(Hurricane categ. 4 | no) = ⅓
P(wildfire extreme | no ) = ⅓
**P(No sig. loss) = 3/15**

P(Quake level 8 | yes) = 3/12
P(Flood max-level | yes) = 1/12
P(Hurricane categ. 4 | yes) = 5/12
P(wildfire extreme | yes ) = 5/12
**P(Yes sig. loss) = 12/15**

P(Q^F^H^W | No ) x P(No)= ⅓ x ⅓ x ⅓ x ⅓ x 3/15 = 0.0025

P(Q^F^H^W | Yes ) x P(Yes)= 3/12 x 1/12 x 5/12 5/12 x 12/15 = 0.0029

# ML: Classificação - Bayes

P(Quake level 8 | no) = ⅓
P(Flood max-level | no) = ⅓
P(Hurricane categ. 4 | no) = ⅓
P(wildfire extreme | no ) = ⅓
**P(No sig. loss) = 3/15**

P(Quake level 8 | yes) = 3/12
P(Flood max-level | yes) = 1/12
P(Hurricane categ. 4 | yes) = 5/12
P(wildfire extreme | yes ) = 5/12
**P(Yes sig. loss) = 12/15**

P(Q^F^H^W | No ) x P(No)= ⅓ x ⅓ x ⅓ x ⅓ x 3/15 = 0.0025

P(Q^F^H^W | Yes ) x P(Yes)= 3/12 x 1/12 x 5/12 5/12 x 12/15 = 0.0029

*Normalizar por P(Q^F^H^W) = 4/15 x 2/15 x 6/15 x 6/15 = 0.0057*

# ML: Classificação - Bayes

P(Quake level 8 | no) = ⅓
P(Flood max-level | no) = ⅓
P(Hurricane categ. 4 | no) = ⅓
P(wildfire extreme | no ) = ⅓
**P(No sig. loss) = 3/15**

P(Quake level 8 | yes) = 3/12
P(Flood max-level | yes) = 1/12
P(Hurricane categ. 4 | yes) = 5/12
P(wildfire extreme | yes ) = 5/12
**P(Yes sig. loss) = 12/15**

P(Q^F^H^W | No ) x P(No)= ⅓ x ⅓ x ⅓ x ⅓ x 3/15 = 0.0025

P(Q^F^H^W | Yes ) x P(Yes)= 3/12 x 1/12 x 5/12 5/12 x 12/15 = 0.0029

*Normalizar por P(Q^F^H^W) = 4/15 x 2/15 x 6/15 x 6/15 = 0.0057*

**P (No | Q^F^H^W) = 0.0025 / 0.0057 = 0.43**

# ML: Classificação - Bayes

P(Quake level 8 | no) = ⅓
P(Flood max-level | no) = ⅓
P(Hurricane categ. 4 | no) = ⅓
P(wildfire extreme | no ) = ⅓
**P(No sig. loss) = 3/15**

P(Quake level 8 | yes) = 3/12
P(Flood max-level | yes) = 1/12
P(Hurricane categ. 4 | yes) = 5/12
P(wildfire extreme | yes ) = 5/12
**P(Yes sig. loss) = 12/15**

P(Q^F^H^W | No ) x P(No)= ⅓ x ⅓ x ⅓ x ⅓ x 3/15 = 0.0025

P(Q^F^H^W | Yes ) x P(Yes)= 3/12 x 1/12 x 5/12 5/12 x 12/15 = 0.0029

*Normalizar por P(Q^F^H^W) = 4/15 x 2/15 x 6/15 x 6/15 = 0.0057*

**P (No | Q^F^H^W) = 0.0025 / 0.0057 = 0.43**

**P (Yes | Q^F^H^W) = 0.0029 / 0.0057 = 0.51**

# ML: Classificação - Bayes

P(Quake level 8 | no) = ⅓
P(Flood max-level | no) = ⅓
P(Hurricane categ. 4 | no) = ⅓
P(wildfire extreme | no ) = ⅓
**P(No sig. loss) = 3/15**

P(Quake level 8 | yes) = 3/12
P(Flood max-level | yes) = 1/12
P(Hurricane categ. 4 | yes) = 5/12
P(wildfire extreme | yes ) = 5/12
**P(Yes sig. loss) = 12/15**

P(Q^F^H^W | No ) x P(No)= ⅓ x ⅓ x ⅓ x ⅓ x 3/15 = 0.0025

P(Q^F^H^W | Yes ) x P(Yes)= 3/12 x 1/12 x 5/12 5/12 x 12/15 = 0.0029

*Normalizar por P(Q^F^H^W) = 4/15 x 2/15 x 6/15 x 6/15 = 0.0057*

**P (No | Q^F^H^W) = 0.0025 / 0.0057 = 0.43**

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# ML: Classificação - Bayes

P(Quake level 8 | no) = ⅓
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P(wildfire extreme | no ) = ⅓
**P(No sig. loss) = 3/15**

P(Quake level 8 | yes) = 3/12
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P(Hurricane categ. 4 | yes) = 5/12
P(wildfire extreme | yes ) = 5/12
**P(Yes sig. loss) = 12/15**

P(Q^F^H^W | No ) x P(No)= ⅓ x ⅓ x ⅓ x ⅓ x 3/15 = 0.0025

P(Q^F^H^W | Yes ) x P(Yes)= 3/12 x 1/12 x 5/12 5/12 x 12/15 = 0.0029

*Normalizar por P(Q^F^H^W) = 4/15 x 2/15 x 6/15 x 6/15 = 0.0057*

**P (No | Q^F^H^W) = 0.0025 / 0.0057 = 0.43**

**P (Yes | Q^F^H^W) = 0.0029 / 0.0057 = 0.51**

**Se Quake level 8 e Flood max-level e Hurricane categ. 4 e Wildfire extreme => Yes Loss**

# ML: Classificação - Bayes

- Treinar com base nas features para prever o label.

```
from sklearn.naive_bayes import MultinomialNB
nb = MultinomialNB()
nb.fit(X_train, y_train)
acuracia_treino = nb.score(X_train , y_train)
acuracia_treino*100
```

```
73.75
```

# ML: Classificação - Bayes

- Vamos medir então o resultado das previsões com dados de teste: acurácia, matriz de confusão, precision e recall.

```
from sklearn.metrics import accuracy_score, confusion_matrix,
preds = nb.predict(X_test)
test_accuracy = accuracy_score(y_test,preds)*100
print(test_accuracy)
cm = confusion_matrix(y_test,preds)
print(cm)
print(classification_report(y_test,preds))
```

```
80.0
[[ 0  3]
 [ 1 16]]
              precision    recall  f1-score   support

           0       0.00      0.00      0.00         3
           1       0.84      0.94      0.89        17

    accuracy                           0.80        20
   macro avg       0.42      0.47      0.44        20
weighted avg       0.72      0.80      0.76        20
```

# Exercício: Bayes

- Analise o Histórico de Crédito e verifique quais são as probabilidades de um cliente ter seu crédito aprovado ou não, utilizando o algoritmo de Bayes.
    - Compare com as classificações realizadas no exercícios anterior
    - Avalie o crédito para um novo conjunto de potenciais clientes.

treino: https://raw.githubusercontent.com/lcbjrrr/data/main/RiscoCredito%20-%20okk.csv
teste: https://raw.githubusercontent.com/lcbjrrr/data/main/RiscoCredito%20-%20prever2.csv


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# ATIVIDADE: Naive Bayes

- Escolha uma base de dados no https://www.kaggle.com/datasets, e se familiarize com sua base
- Procure realizar a previsão (inferência) de uma variável categórica através de um Naive Bayes. Se certifique de medir seus níveis de assertividade. Esteja a vontade a realizar mais um hiperparâmetro (número de vizinhos) de um e compará-los
- Não esqueça de junto com seus códigos realizar suas análises/conclusões (use o botão de +Texto).

# ML: Classificação - Bayes

| 1 | previsao | temperatura | umidade | vento | jogar |
|---|---|---|---|---|---|
| 2 | ensolarado | quente | alta | nao_ventando | nao ✗ |
| 3 | ensolarado | quente | alta | ventando | nao ✗ |
| 4 | nublado | quente | alta | nao_ventando | sim ✓ |
| 5 | chuvoso | brando | alta | nao_ventando | sim ✓ |
| 6 | chuvoso | frio | normal | nao_ventando | sim ✓ |
| 7 | chuvoso | frio | normal | ventando | nao ✗ |
| 8 | nublado | frio | normal | ventando | sim ✓ |
| 9 | ensolarado | brando | alta | nao_ventando | nao ✗ |
| 10 | ensolarado | frio | normal | nao_ventando | sim ✓ |
| 11 | chuvoso | brando | normal | nao_ventando | sim ✓ |
| 12 | ensolarado | brando | normal | ventando | sim ✓ |
| 13 | nublado | brando | alta | ventando | sim ✓ |
| 14 | nublado | quente | normal | nao_ventando | sim ✓ |
| 15 | chuvoso | brando | alta | ventando | nao |