

1. Section 1

Starting Equations:

$$\begin{aligned}class1 : A &= [2, 2]^T, B = [3, 5]^T \\class1_bias : A &= [1, 2, 2]^T, B = [1, 3, 5]^T \\class2 : C &= [1, 3]^T, D = [-1, -0.5]^T \\class2_bias : C &= [1, 1, 3]^T, D = [1, -1, -0.5]^T \\initial_weight_vector : W0 &= [1, 1, 1]^T\end{aligned}$$

First Step of weight vector updating:

$$\begin{aligned}W0 * A &= 5(OK) \\W0 * B &= 9(OK) \\W0 * C &= 5(NOTOK) \\W1 &= W0 - C = [0, 0, -2] \\W1 * D &= 1(NOTOK) \\W2 &= W1 - D = [-1, 1, -1.5]\end{aligned}$$

Second Step of weight vector updating:

$$\begin{aligned}W2 * A &= -2(NOTOK) \\W3 &= W2 + A = [0, 3, 0.5] \\W3 * B &= 11.5(OK) \\W3 * C &= 4.5(NOTOK) \\W4 &= W3 - C = [-1, 2, -2.5] \\W4 * D &= -1.75(OK)\end{aligned}$$

Third Step of weight vector updating:

$$\begin{aligned}W4 * A &= -2(NOTOK) \\W5 &= W4 + A = [0, 4, -0.5] \\W5 * B &= 9.5(OK) \\W5 * C &= 2.5(NOTOK) \\W6 &= W5 - C = [-1, 3, -3.5] \\W6 * D &= -2.25(OK)\end{aligned}$$

Four Step of weight vector updating:

$$\begin{aligned}W6 * A &= -2(NOTOK) \\W7 &= W6 + A = [0, 5, -1.5] \\W7 * B &= 7.5(OK) \\W7 * C &= 0.5(NOTOK) \\W8 &= W7 - C = [-1, 4, -4.5] \\W8 * D &= -2.75(OK)\end{aligned}$$

Five Step of weight vector updating:

$$\begin{aligned}W8 * A &= -2(NOTOK) \\W9 &= W8 + A = [0, 6, -2.5] \\W9 * B &= 5.5(OK) \\W9 * C &= -1.5(OK) \\W9 * D &= -4.75(OK)\end{aligned}$$

Final result:

$$\begin{aligned}W9 * A &= 7.000000 \\W9 * B &= 5.500000 \\W9 * C &= -1.500000 \\W9 * D &= -4.750000 \\W9 &= [0, 6, -2.5]\end{aligned}$$

2. Section 2

By Hand:

```
probability <- .6
number_of_weak_learners <- 7
x <- ceiling(number_of_weak_learners/2)
final_sum <- 0

for(i in number_of_weak_learners:x) {
  binomial_coefficient <- (factorial(number_of_weak_learners) /
                           (factorial(i) * factorial(number_of_weak_learners-i)))

  p <- probability^i
  np <- (1-probability)^(number_of_weak_learners-i)
  final_sum <- final_sum + (binomial_coefficient * p * np)
}
print(final_sum)
```

R Packages:

```
final_sum <- dbinom(7, size=7, prob=0.6) +
             dbinom(6, size=7, prob=0.6) +
             dbinom(5, size=7, prob=0.6) +
             dbinom(4, size=7, prob=0.6)
```

ANSWER: 71.0208% majority vote accuracy

3. Section 3

4. Section 4

Information gain for attributes:

$$\begin{aligned} \textit{gain}(\textit{Color}) &= 0.540852082972755 \textit{ bits} \\ \textit{gain}(\textit{Shape}) &= 0 \textit{ bits} \\ \textit{gain}(\textit{Size}) &= 0.459147917027245 \textit{ bits} \end{aligned}$$

Best Root Node Attribute = Color

5. Section 5