

Name	Body Temperature	Skin Cover	Gives Birth	Aquatic Creature	Aerial Creature	Has Legs	Hibernates	Class
Human	warm-blooded	hair	yes	no	no	yes	No	mammal
Python	cold-blooded	scales	no	no	no	no	Yes	Reptile
Salmon	cold-blooded	scales	no	yes	no	no	No	Fish
Whale	warm-blooded	hair	yes	yes	no	no	no	Mammal
Frog	cold-blooded	none	no	semi	no	yes	yes	amphibian
Komodo Dragon	cold-blooded	scales	no	no	no	yes	no	Reptile
Bat	warm-blooded	hair	yes	no	yes	yes	yes	Mammal
Pigeon	warm-blooded	feathers	no	no	yes	yes	no	Bird
Cat	warm-blooded	fur	yes	no	no	yes	no	Mammal
Leopard Shark	cold-blooded	scales	yes	yes	no	no	no	Fish
Turtle	cold-blooded	scales	no	semi	no	yes	no	Reptile
Penguin	warm-blooded	feathers	no	semi	no	yes	no	Bird
Porcupine	warm-blooded	quills	yes	no	no	yes	yes	Mammal
Eel	cold-blooded	scales	no	yes	no	no	no	Fish
Salamander	cold-blooded	none	no	semi	no	yes	yes	amphibian

Root Set(D)

Mammal = 5, Reptile= 3, Fish = 3, Amphibian = 2, Bird = 2

Entropy of root set:

Info(D) =

$$- 5/15 * \log_2 (5/15) - 3/15 * \log_2 (3/15) - 3/15 * \log_2 (3/15) - 2/15 * \log_2 (2/15) - 2/15 * \log_2 (2/15)$$

$$= 0.67/0.3 = 2.23$$

Splitting on base of body temperature:

warm-blooded:

Mammal = 5, Reptile= 0, Fish = 0, Amphibian = 0, Bird = 2

$$\text{Info}_{\text{BT1}}(D) = - 5/7 * \log_2 (5/7) - 2/7 * \log_2 (2/7) = (0.26)/0.3 = 0.866$$

cold-blooded:

Mammal = 0, Reptile= 3, Fish = 3, Amphibian = 2, Bird = 0

$$\text{Info}_{\text{BT2}}(D) = - 3/8 * \log_2 (3/8) - 3/8 * \log_2 (3/8) - 2/8 * \log_2 (2/8) = 1.06+0.5 = 1.56$$

$$\text{Info}_{\text{BT}}(D) = (7/15)*0.866 +(8/15)* 1.56 = 1.23$$

$$\text{Gain}(\text{Blood Type}) = \text{Info}(D) - \text{Info}_{\text{BT}}(D) = 2.23-1.23 = 1$$

$$\text{Split Info}_{\text{BT}}(D) = -(7/15) * \log_2 (7/15) - (8/15) * \log_2 (8/15) = .515+ .485 = 1$$

$$\text{Gain Ratio}(\text{Blood Type}) = \text{Gain}(\text{Blood Type}) / \text{Split Info}(\text{Blood Type})$$

$$= 1/1 = 1$$

Splitting on base of Skin Cover:

hair:

Mammal = 3, Reptile= 0, Fish = 0, Amphibian = 0, Bird = 0

$$\text{Info}_{\text{BT1}}(D) = - 3/3 * \log_2 (3/3) = 0$$

scales:

Mammal = 0, Reptile= 3, Fish = 3, Amphibian = 0, Bird = 0

$$\text{Info}_{\text{BT2}}(D) = - 3/6 * \log_2 (3/6) - 3/6 * \log_2 (3/6) = - \log_2 (1/2) = 1$$

none:

Mammal = 0, Reptile= 0, Fish = 0, Amphibian = 2, Bird = 0

$$\text{Info}_{\text{BT3}}(D) = - 2/2 * \log_2 (2/2) = 0$$

Feather:

Mammal = 0, Reptile= 0, Fish = 0, Amphibian = 0, Bird = 2

$$\text{Info}_{\text{BT4}}(D) = - 2/2 * \log_2 (2/2) = 0$$

Fur:

Mammal = 1, Reptile= 0, Fish = 0, Amphibian = 0, Bird = 0

$$\text{Info}_{\text{BT5}}(D) = - 1/1 * \log_2 (1) = 0$$

Quills:

Mammal = 1, Reptile= 0, Fish = 0, Amphibian = 0, Bird = 0

$$\text{Info}_{\text{BT6}}(D) = - 1/1 * \log_2 (1) = 0$$

$$\text{Info}_{\text{BT}}(D) = (6/15)*1 = 0.4$$

$$\text{Gain}(\text{Skin}) = \text{Info}(D) - \text{Info}_{\text{BT}}(D) = 2.23 - 0.4 = 1.83$$

$$\text{Split Info}(D) = -(3/15) * \log_2 (3/15) - (6/15) * \log_2 (6/15) - 2 * (2/15) * \log_2 (2/15) - 2 * (1/15) * \log_2 (1/15) = .466+.53+.78+.522= 2.3$$

$$\text{Gain Ratio}(\text{Skin}) = \text{Gain}(\text{Skin}) / \text{Split Info}(\text{Skin}) = 1.83/2.3 = 0.79$$

Splitting on base of Birth:

Gives birth (Yes):

Mammal = 5, Reptile= 0, Fish = 1, Amphibian = 0, Bird = 0

$$\text{Info}_{\text{BT1}}(D) = -5/6 * \log_2(5/6) - 1/6 * \log_2(1/6) = 0.22+0.43 = 0.65$$

No:

Mammal = 0, Reptile= 3, Fish = 2, Amphibian = 2, Bird = 2

$$\text{Info}_{\text{BT2}}(D) = -3/9 * \log_2(3/9) - 3*2/9 * \log_2(2/9) = 0.42 + 1.45 = 1.87$$

$$\text{Info}_{\text{BT}}(D) = (6/15)*0.65 + (9/15)* 1.87 = 1.38$$

$$\text{Gain}(\text{Birth}) = \text{Info}(D) - \text{Info}_{\text{BT}}(D) = 2.23-1.38 = 0.85$$

$$\text{Split Info}_{\text{BT}}(D) = -(6/15) * \log_2(6/15) - (9/15) * \log_2(9/15) = .53+ .52 = 1.05$$

$$\text{Gain Ratio}(\text{Birth}) = \text{Gain}(\text{Birth}) / \text{Split Info}(\text{Birth}) = 0.85/1.05 = 0.81$$

Splitting on base of being Aquatic:

Yes:

Mammal = 1, Reptile= 0, Fish = 3, Amphibian = 0, Bird = 0

$$\text{Info}_{\text{BT1}}(D) = -1/4 * \log_2(1/4) - 3/4 * \log_2(3/4) = 0.81$$

No:

Mammal = 4, Reptile= 2, Fish = 0, Amphibian = 0, Bird = 1

$$\text{Info}_{\text{BT2}}(D) = -4/7 * \log_2(4/7) - 2/7 * \log_2(2/7) - 1/7 * \log_2(1/7) = 0.46+0.52+0.4= 1.4$$

Semi:

Mammal = 0, Reptile=1, Fish = 0, Amphibian = 2, Bird = 1

$$\text{Info}_{\text{BT1}}(D) = -2 \cdot \frac{1}{4} \cdot \log_2\left(\frac{1}{4}\right) - \frac{2}{4} \cdot \log_2\left(\frac{2}{4}\right) = 1.5$$

$$\text{Info}_{\text{BT}}(D) = \left(\frac{4}{15}\right) \cdot 0.81 + \left(\frac{7}{15}\right) \cdot 1.4 + \left(\frac{4}{15}\right) \cdot 1.5 = 0.216 + 0.65 + 0.4 = 1.27$$

$$\text{Gain}(\text{Aquatic}) = \text{Info}(D) - \text{Info}_{\text{BT}}(D) = 2.23 - 1.27 = 0.96$$

$$\text{Split Info}_{\text{BT}}(D) = -2 \cdot \left(\frac{4}{15}\right) \cdot \log_2\left(\frac{4}{15}\right) - \left(\frac{7}{15}\right) \cdot \log_2\left(\frac{7}{15}\right) = 1.02 + .515 = 1.535$$

$$\text{Gain Ratio}(\text{Aquatic}) = \text{Gain}(\text{Aquatic}) / \text{Split Info}(\text{Aquatic}) = 0.96 / 1.535 = 0.625$$

Splitting on base of being Aerial:

Yes:

Mammal = 1, Reptile= 0, Fish = 0, Amphibian = 0, Bird = 1

$$\text{Info}_{\text{BT1}}(D) = -2 \cdot 0.5 \cdot \log_2(0.5) = -\log_2(0.5) = 1$$

No:

Mammal = 4, Reptile= 3, Fish = 3, Amphibian = 2, Bird = 1

$$\begin{aligned} \text{Info}_{\text{BT2}}(D) &= -\frac{4}{13} \cdot \log_2\left(\frac{4}{13}\right) - 2 \cdot \frac{3}{13} \cdot \log_2\left(\frac{3}{13}\right) - \frac{2}{13} \cdot \log_2\left(\frac{2}{13}\right) - \frac{1}{13} \cdot \log_2\left(\frac{1}{13}\right) \\ &= 0.525 + 0.98 + 0.42 + 0.286 = 2.21 \end{aligned}$$

$$\text{Info}_{\text{BT}}(D) = \left(\frac{2}{15}\right) \cdot 1 + \left(\frac{13}{15}\right) \cdot 2.21 = 2.05$$

$$\text{Gain}(\text{Birth}) = \text{Info}(D) - \text{Info}_{\text{BT}}(D) = 2.23 - 2.05 = 0.18$$

$$\text{Split Info}_{\text{BT}}(D) = -\left(\frac{2}{15}\right) \cdot \log_2\left(\frac{2}{15}\right) - \left(\frac{13}{15}\right) \cdot \log_2\left(\frac{13}{15}\right) = .39 + .18 = .57$$

$$\text{Gain Ratio}(\text{Birth}) = \text{Gain}(\text{Birth}) / \text{Split Info}(\text{Birth}) = 0.18 / .57 = 0.31$$

Splitting on base of having Legs:

Yes:

Mammal = 4, Reptile= 2, Fish = 0, Amphibian = 2, Bird = 2

$$\text{Info}_{\text{BT1}}(D) = -3*0.2 * \log_2(0.2) - 0.4 * \log_2(0.4) = 1.4+0.53 = 1.93$$

No:

Mammal = 1, Reptile= 1, Fish = 3, Amphibian = 0, Bird = 0

$$\text{Info}_{\text{BT2}}(D) = -0.6 * \log_2(0.6) - 2*0.2 * \log_2(0.2) = 0.44+0.93 = 1.37$$

$$\text{Info}_{\text{BT}}(D) = (10/15)*1.93 +(5/15)* 1.37 = 1.74$$

$$\text{Gain}(\text{Legs}) = \text{Info}(D) - \text{Info}_{\text{BT}}(D) = 2.23-1.74 = 0.49$$

$$\text{Split Info}_{\text{BT}}(D) = -(10/15) * \log_2(10/15) - (5/15) * \log_2(5/15) = .39+ .53 = .92$$

$$\text{Gain Ratio}(\text{Legs}) = \text{Gain}(\text{Legs}) / \text{Split Info}(\text{Legs}) = 0.49/.92 = 0.53$$

Splitting on base of Hibernation:

Yes:

Mammal = 2, Reptile= 1, Fish = 0, Amphibian = 2, Bird = 0

$$\text{Info}_{\text{BT1}}(D) = -1*0.2 * \log_2(0.2) - 2*0.4 * \log_2(0.4) = .46+1.06 = 1.52$$

No:

Mammal = 3, Reptile= 2, Fish = 3, Amphibian = 0, Bird = 2

$$\text{Info}_{\text{BT2}}(D) = -2*0.3 * \log_2(0.3) - 2*0.2 * \log_2(0.2) = 1.04+0.93 = 1.97$$

$$\text{Info}_{\text{BT}}(D) = (10/15)*1.97 +(5/15)* 1.52 = 1.82$$

$$\text{Gain(Legs)} = \text{Info(D)} - \text{Info}_{\text{BT}}(\text{D}) = 2.23 - 1.82 = 0.41$$

$$\text{Split Info}_{\text{BT}}(\text{D}) = -\left(\frac{10}{15}\right) * \log_2\left(\frac{10}{15}\right) - \left(\frac{5}{15}\right) * \log_2\left(\frac{5}{15}\right) = .39 + .53 = .92$$

$$\text{Gain Ratio (Legs)} = \text{Gain (Legs)} / \text{Split Info (Legs)} = 0.41 / .92 = 0.45$$

Since Gain ratio for splitting on Blood Type is highest. So we will split on Blood-Type