**1. Suppose we are trying to distinguish cats from dogs and the only measurement we have is weight. Let the prior probabilities for cats and dogs be P(CAT) = 0.3, p(DOG) = 0.7 and let the class conditional density functions for (integer-valued) weight given class be uniformly distributed as follows:**
**–P(Weight|CAT) is uniform on [20, 39]**
**–P(Weight|DOG) is uniform on [30,59].**
**Explain how Bayes' rule can be used to classify an unknown animal having weight 35 pounds given the prior and conditional probabilities defined above.**
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**Solution**: The Bayes formula for this problem is:

$$P(X \mid weight) = \frac{P(weight \mid X)P(X)}{\sum_{Y \in \{\text{CAT, DOG}\}} P(weight \mid Y)P(Y)}$$

where $X \in \{\text{CAT, DOG}\}$. Given $P(\text{CAT}) = 0.3$, $P(\text{DOG}) = 0.7$

$$p(weight \mid \text{CAT}) = \frac{1}{39-20+1} = \frac{1}{20}$$

$$p(weight \mid \text{DOG}) = \frac{1}{59-30+1} = \frac{1}{30},$$

we have

$$P(\text{CAT} \mid 35) = \frac{P(35 \mid \text{CAT})P(\text{CAT})}{P(35 \mid \text{CAT})P(\text{CAT}) + P(35 \mid \text{DOG})P(\text{DOG})}$$

$$= \frac{\frac{1}{20}0.3}{\frac{1}{20}0.3 + \frac{1}{30}0.7} \approx 0.3913$$

$$P(\text{DOG} \mid 35) = \frac{P(35 \mid \text{DOG})P(\text{DOG})}{P(35 \mid \text{CAT})P(\text{CAT}) + P(35 \mid \text{DOG})P(\text{DOG})}$$

$$= \frac{\frac{1}{30}0.7}{\frac{1}{20}0.3 + \frac{1}{30}0.7} \approx 0.6087$$

Since $P(\text{DOG} \mid 35) > P(\text{CAT} \mid 35)$, the animal is more likely to be a dog.