Bayes' theorem in AI | Example 1

1. **Goal**: Calculate **P(B|A)** (likelihood it will rain given there are clouds).**(likelihood)**
2. What we know:
    - **P(A):** How likely it is to rain in general **(Prior Knowledge)**.
    - **P(A|B):** How likely it is to rain if there are clouds **(Evidence).**
3. **Question:**
    - What is the likelihood of clouds given it rains (P(B|A))? **(posterior)**

What We Know

1. **P(A):** Probability it will rain >>> **30%** chance it rains today.
2. **P(A|B):** Probability it will rain if there are clouds. >>> **80%** chance of rain.
3. **P(B):** Probability of clouds **50%** chance of clouds on any given day.

What is **P(B|A) = ?**

https://www.cecmohali.org/public/documents/cse/material/ppt/ai-ppt-3.pdf

Bayes' theorem in AI | Example 2

1. **Given clouds in the morning, what's the probability of rain in the afternoon?**
2. **80% of rainy afternoons start with cloudy mornings.** 3. **40% of days have cloudy mornings.** 4. **10% of days have rainy afternoons.**

$$P(\text{rain}|\text{clouds}) = \frac{P(\text{clouds}|\text{rain})\ P(\text{rain})}{P(\text{clouds})}$$

$$\frac{0.8\ 0.1}{0.4} = 0.2$$

https://www.slideshare.net/slideshow/probabilistic-reasoning-aipptx/257807391

Bayes' theorem in AI

Knowing

P(cloudy morning | rainy afternoon)

we can calculate

P(rainy afternoon | cloudy morning)

https://www.slideshare.net/slideshow/probabilistic-reasoning-aipptx/257807391

Bayes' theorem in AI

Knowing

P(visible effect | unknown cause)

we can calculate

P(unknown cause | visible effect)

https://www.slideshare.net/slideshow/probabilistic-reasoning-aipptx/257807391

Bayes' theorem in AI | Eample 3

What We Know

1. **P(A):** Probability it will rain >>> **20%** chance it rains today.
2. **P(A|B):** Probability it will rain if there are clouds. >>> **70%** chance of rain.
3. **P(B):** Probability of clouds **50%** chance of clouds on any given day.

What is **P(B|A) = ?**

Example Calculation

1. What we know:
   - P(A) (rain): 0.20
   - P(A|B) (rain if clouds): 0.70
   - P(B) (clouds): 0.50

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

$$P(B|A) = \frac{0.70 \cdot 0.50}{0.20} = 87.5\%$$

Reducing Uncertainty:

- Initially, the probability of clouds was 50%. After observing rain, this updates to 87.5%, making the prediction much more confident.

Bayes' theorem in AI

P(Temperature-High)=**30%** (likelihood of high temperature on any day).

- P(Rain|Clouds) = **70%** (probability of rain given clouds).
- P(Temperature-High I Clouds)=**20%**
- P(Temperature-High I Rain)=**50%**

What is $P(Clouds|Rain, Temperature\text{-High})$?

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

If it rained and the temperature is high, the probability of clouds **decreases to 70%**

Bayes' theorem | Practice Example

Company A supplies 40% of the computers sold and is late 5% of the time. Company B supplies 30% of the computers sold and is late 3% of the time. Company C supplies another 30% and is late 2.5% of the time. A computer arrives late - what is the probability that it came from Company A?

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

Bayes' theorem | Practice Example

Company A supplies 40% of the computers sold and is late 5% of the time.
Company B supplies 30% of the computers sold and is late 3% of the time.
Company C supplies another 30% and is late 2.5% of the time.
A computer arrives late - what is the probability that it came from Company A?

P(A) = 0.4
P(B) = 0.3
P(C) = 0.3
P(Late | A) = 0.05
P(Late | B) = 0.03
P(Late | C) = 0.025
P(A | Late) = P(Late|A) P(A)

P(late)

P(late) =

Joint Probability
P(Late|A)*P(A) + P(Late

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

Joint Probability
P(Late|A)*P(A) + P(Late |B)P(B) + P(Late | C) P(C) = 0.0365

p(A | Late) = (0.05)(0.4) \ 0.0365 = 0.54 = 54%

Bayes' theorem | Practice Example

A mechanic knows these facts:

If a car has engine trouble, it makes a loud noise 80% of the time.
The chance of a car having engine trouble is 0.000033.
The chance of a car making a loud noise is 2%.

What is the chance that a car making a loud noise actually has engine trouble?

Bayes' theorem | Example Simplified

A mechanic knows these facts:

If a car has engine trouble, it is likely to make a loud noise 80% of the time.

(This means **P(A | B)=0.80**, where **A = loud noise and B = engine trouble).**

The chance of a car having engine trouble is very small, only 0.000033.

(This means **P(B)=0.000033**).

The chance of any car making a loud noise is 2%.

(This means **P(A)=0.02**).

The question is:

If a car is making a loud noise, what is the chance it actually has engine trouble?

(You need to find **P(B | A)**)

Bayes' theorem | Example Solution

$$P(B|A) = \frac{0.80 \cdot 0.000033}{0.02} = 0.0013\%$$