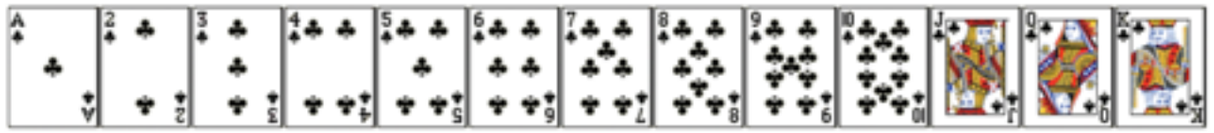
BAYES THEOREM

YOU COME HOME, AND FIND THE CONTENTS OF YOUR TRASH CAN SPREAD ALL OVER YOUR HOME

WAS IT YOUR PET DOG?

OR WAS IT SOMETHING ELSE, MAYBE A BEAR?



YOU WIN IF YOU GET A FACE CARD. WHAT IS THE PROBABILITY THAT YOU'LL WIN?

P(You get a face card) = 3/13

BUT, WHAT IF YOU KNEW WHICH CARDS SARAH AND MARK WERE DEALT?

P(You get a face card **given** Sarah got a face card) = 2/12

P(You get a face card **given** Sarah got a face card **and given** Mark got a face card) = 1/11

YOUR PREDICTION FOR YOUR CHANCES OF WINNING CHANGES WHEN YOU HAVE PRIOR KNOWLEDGE ABOUT WHICH CARDS WERE DEALT

WHAT IS CONDITIONAL PROBABILITY?

Definition. The **conditional probability** of an event A given that an event B has occurred is written:

$$P(A|B)$$

and is calculated using:

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

P(You get a face card **AND** Sarah got a face card)

as long as $P(B) > 0$.

P(You get a face card **given** Sarah got a face card)

A → You getting a face card

B → Sarah getting a face card

P(You get a face card **AND** Sarah got a face card) = P(Sarah got a face card) * P(You get a face card **given** Sarah got a face card)

= 3/13 * 2/12 = 1/26

$$P(\text{You get a face card } \textbf{given} \text{ Sarah got a face card}) = \frac{P(\text{You get a face card } \textbf{AND} \text{ Sarah got a face card})}{P(\text{Sarah got a face card})}$$

$$P(\text{Sarah got a face card } \textbf{given} \text{ You get a face card }) = \frac{P(\text{You get a face card } \textbf{AND} \text{ Sarah got a face card})}{P(\text{You got a face card})}$$

WAS IT YOUR PET DOG?

OR WAS IT SOMETHING ELSE,
MAYBE A BEAR?

(ROVER IS A GREAT DOG,
SO ITS QUITE UNLIKELY THAT
HE WAS NAUGHTY)

PROBABABILITY (DOG ATE TRASH) = $P(D)$ = 0.3

PROBABABILITY (DOG DID NOT EAT THE TRASH) = $\overline{P(D)}$ = 0.7 (THIS JUST FOLLOWS FROM THE LINE ABOVE)

PROBABABILITY (TRASH IS ON THE FLOOR IF DOG ATE IT) = $P(T/D)$ = 0.8

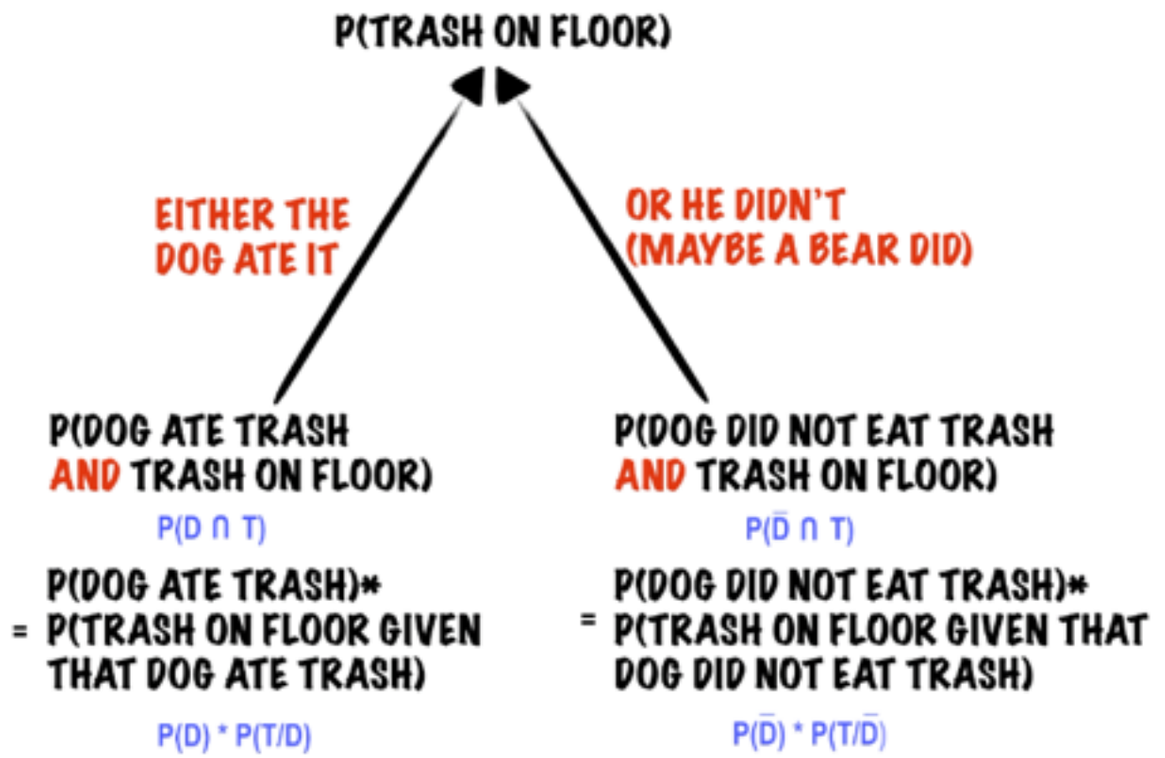
THIS BTW IS A "CONDITIONAL PROBABILITY"

PROBABABILITY (TRASH IS ON THE FLOOR IF DOG DID NOT EAT IT) = $P(T/\overline{D})$ = 0.01

THERE ARE N'T REALLY A LOT OF BEARS OR SQUIRRELS IN APARTMENT COMPLEXES IN BANGALORE

SO - WAS IT YOUR PET DOG OR NOT?

(THE TRASH IS STREWN ALL OVER THE FLOOR,
AND YOU CAN SEE ANIMAL FOOTPRINTS -
THAT MUCH IS AN UNDENIABLE FACT)


P(TRASH ON FLOOR)
EITHER THE DOG ATE IT
OR HE DIDN'T (MAYBE A BEAR DID)
P(DOG ATE TRASH AND TRASH ON FLOOR)
P(D ∩ T)
= P(DOG ATE TRASH)* P(TRASH ON FLOOR GIVEN THAT DOG ATE TRASH)
P(D) * P(T/D)
P(DOG DID NOT EAT TRASH AND TRASH ON FLOOR)
P(D̄ ∩ T)
= P(DOG DID NOT EAT TRASH)* P(TRASH ON FLOOR GIVEN THAT DOG DID NOT EAT TRASH)
P(D̄) * P(T/D̄)

BAYES' THEOREM

P(DOG ATE TRASH GIVEN THAT TRASH IS ON FLOOR) =

P(TRASH IS ON FLOOR **AND** THAT DOG ATE TRASH)

P((TRASH IS ON FLOOR **AND** THAT DOG ATE TRASH)

OR

(TRASH IS ON FLOOR **AND** THAT DOG DID NOT EAT TRASH))

$$P(D/T) = \frac{P(T \cap D)}{P(T \cap D) + P(T \cap \overline{D})}$$

$$= \frac{P(T/D) \cdot P(D)}{P(T/D) \cdot P(D) + P(T/\overline{D}) \cdot P(\overline{D})}$$

$$= \frac{0.8 \cdot 0.3}{0.8 \cdot 0.3 + 0.01 \cdot 0.7}$$

$$= \frac{24}{24.7} = 97\%$$

IS THE NAME FOR THE LITTLE TEST WE JUST APPLIED

SORRY POOCH, BUT THE NUMBERS SAY YOU DID IT!

IT TURNS OUT BAYES' THEOREM IS THE FOUNDATION OF SOME PRETTY COOL AND POWERFUL ML TECHNIQUES_