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?

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)

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))

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

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

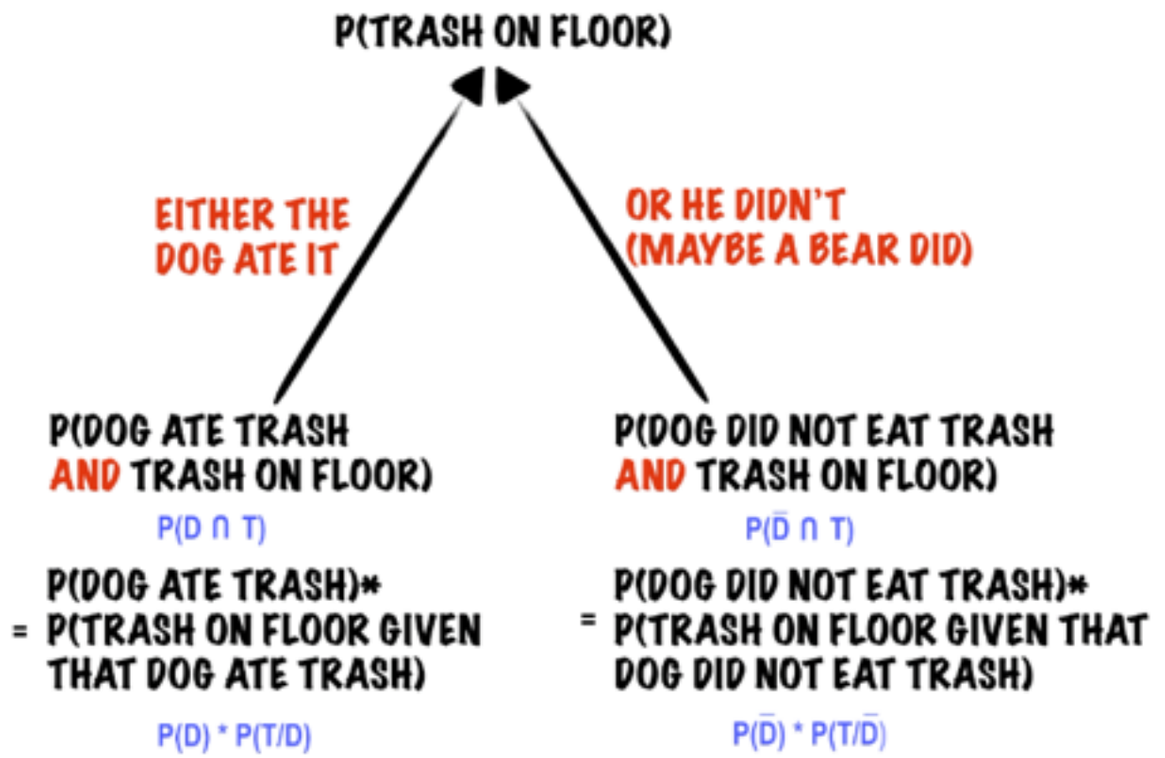
$$= \frac{0.8 \cdot 0.3}{0.8 \cdot 0.3 + 0.01 \cdot 0.7}$$

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

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_


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)

LET'S GO BACK AND UNDERSTAND
ALL OF THIS IN MORE DETAIL

IN OUR PET DOG EXAMPLE, HOW DID
WE CONCLUDE THAT IT WAS OUR LITTLE
PET THAT WAS RESPONSIBLE FOR THE
MESS?

AFTER ALL, WE HAD MENTIONED
THAT THE PROBABILITY OF OUR DOG
GETTING INTO THE TRASH WAS ONLY
30%, BECAUSE HE IS SO WELL-BEHAVED..

WHERE, THEN, DID THE 97% PROBABILITY
COME FROM?

WHICH ONE IS IT - 97% OR 30%? SURELY
BOTH CAN'T BE TRUE?

SO - THE THING TO REALIZE IS: THE 30%
PROBABILITY DOES NOT TAKE INTO ACCOUNT
THE OUTCOME (FACT THAT THE GARBAGE
WAS INDEED STREWN OVER THE FLOOR)

WHILE THE 97% DOES

THE 30% PROBABILITY IS CALLED THE
BEFORE-THE-FACT PROBABILITY, OR MORE
IMPRESSIVELY the a priori probability

THE 97% NUMBER TAKES INTO ACCOUNT
THAT
A. THE HOUSE IS IN A MESS, AND THERE
ARE ANIMAL FOOTPRINTS ON THE FLOOR, AND
B. THAT THERE JUST ARE NOT MANY BEARS
OR OTHER ANIMALS IN APARTMENTS IN
BANGALORE

HENCE THE ONLY 1% PROBABILITY
THAT A BEAR WAS RESPONSIBLE

THIS 97% PROBABILITY, WHICH FULLY PRICES IN ALL OF THE INFORMATION THAT WE HAVE, IS CALLED THE "AFTER-THE-FACT PROBABILITY" OR THE the a posteriori probability

EVEN IF YOU DON'T RECALL THE EXACT FORM OF BAYES' RULE, ITS FINE - JUST REMEMBER THIS:

AFTER-THE-FACT PROBABILITIES TAKE INTO ACCOUNT MORE INFORMATION THAN BEFORE-THE-FACT PROBABILITIES, AND SO ARE MORE INSIGHTFUL

P(Dog ate Trash given that Trash is on floor)

AFTER-THE-FACT

=

THAT'S EXACTLY WHAT BAYES' RULE DOES FOR US

LIKELIHOOD

P(Trash was on floor given that Dog ate trash)

x P(Dog ate Trash)

BEFORE-THE-FACT

P(Trash is on floor)

EVIDENCE

SIMILARLY..

P(Bear ate Trash given that Trash is on floor)

=

P(Trash was on floor given that Bear ate trash)

x P(Bear ate Trash)

P(Trash is on floor)

THEN, TO KNOW IF THE TRASH WAS EATEN BY DOG OR BEAR, WE SIMPLY NEED TO COMPUTE THE NUMERATORS - THE DENOMINATOR IS NOT REQUIRED

THIS IS PRECISELY THE FOUNDATION OF A

NAIVE BAYES CLASSIFIER