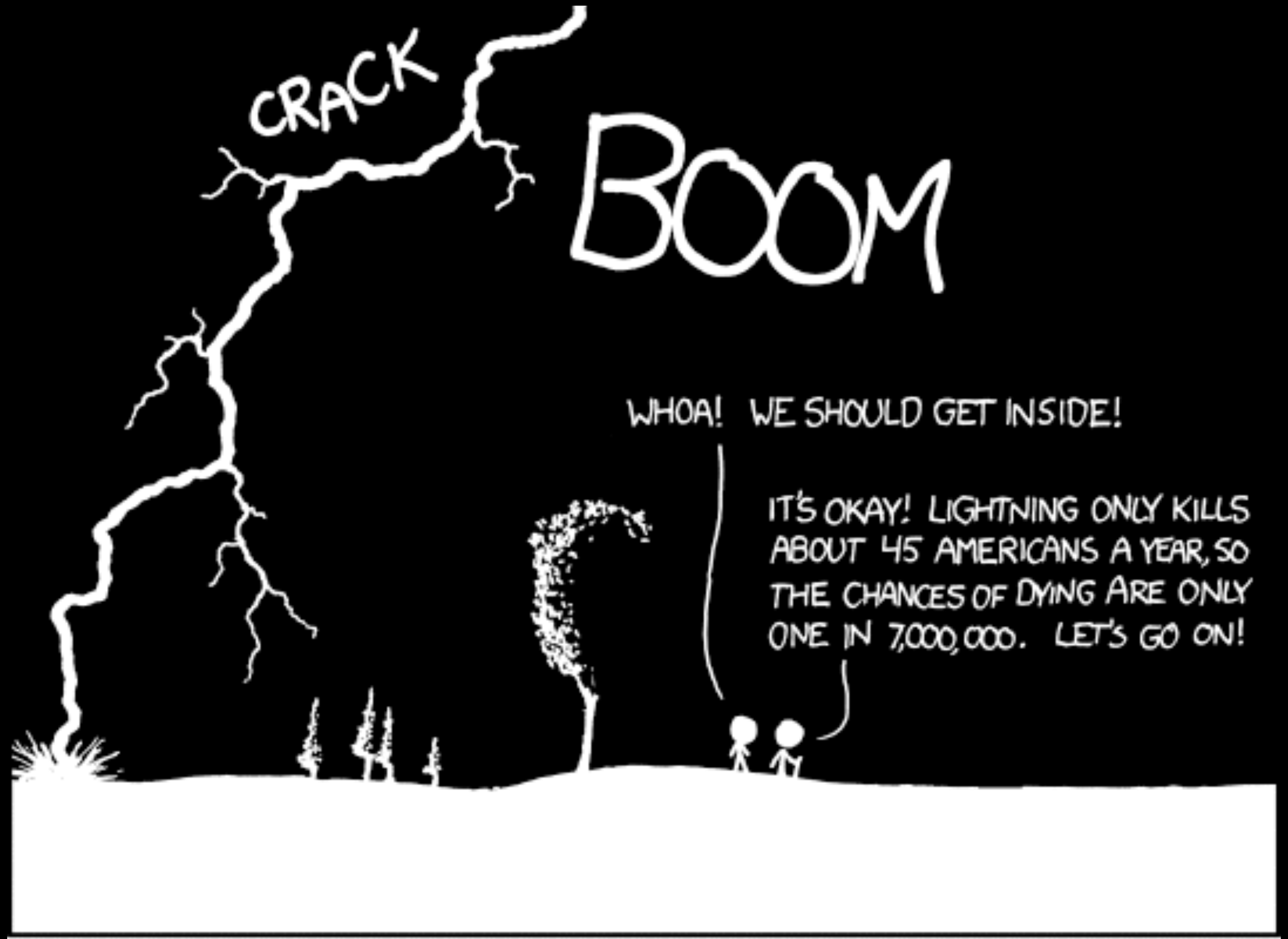
CRITICAL REASONING FOR INTELLIGENCE ANALYSTS

BAYESIAN REASONING



THE ANNUAL DEATH RATE AMONG PEOPLE WHO KNOW THAT STATISTIC IS ONE IN SIX.

HTTPS://XKCD.COM/795/

AT THE DOCTORS...

You are being tested for a disease that affects 1% of the population.

The test has a true positive rate of 90% and a false positive rate of 5%.

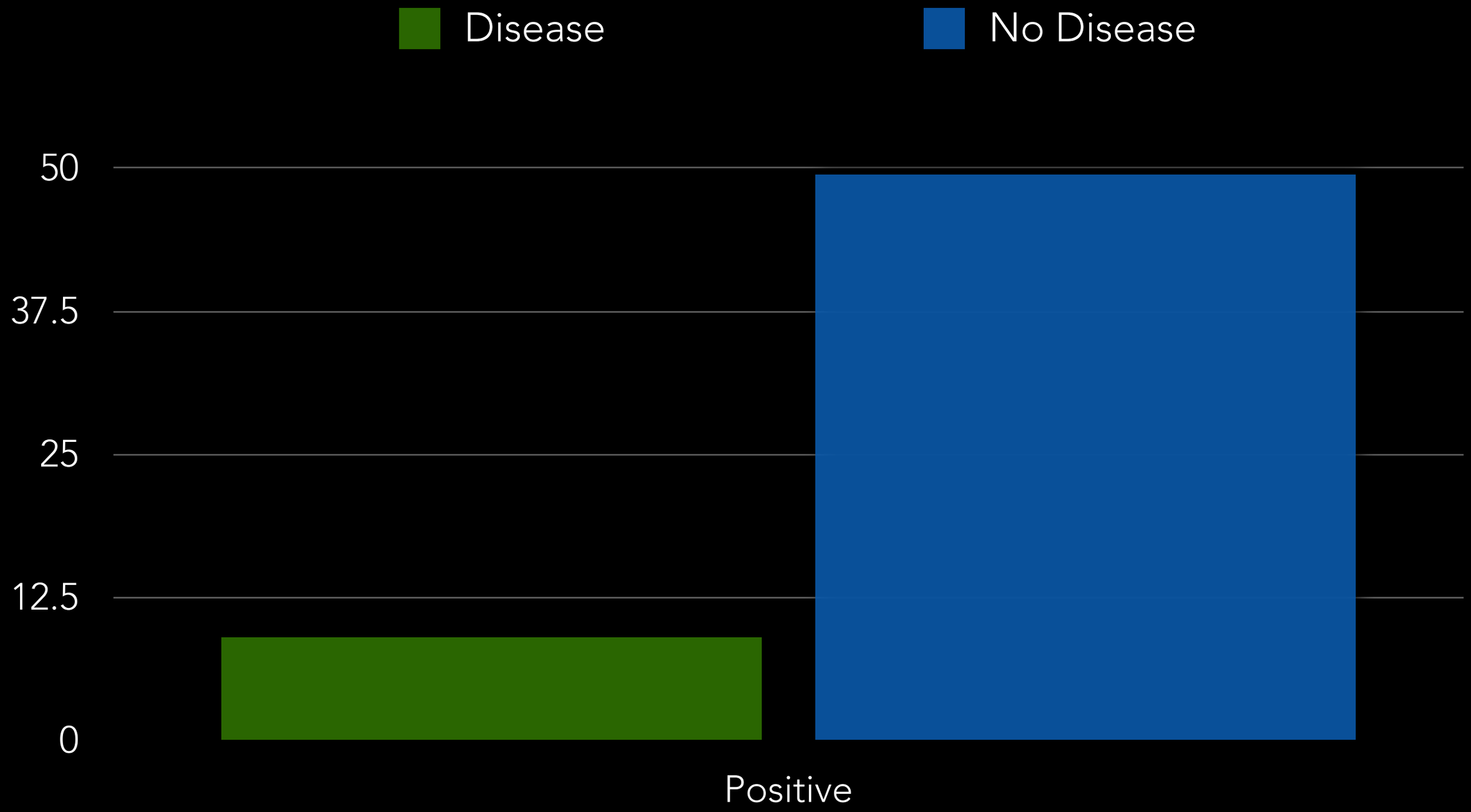
Unfortunately, your test comes back positive.

What is your probability of having the disease?

DID YOU GUESS HIGHER

THAN 18%?

- 1000 people take the test
- 10 have the disease, 990 don’t
- 10 people have a 90% chance of testing positive correctly (9)
- 990 people each have a 5% chance of testing positive incorrectly (49)


Disease
No Disease
50
37.5
25
12.5
0
Positive

BAYESIAN REASONING

CAN HELP.

$$p(H|E) = \frac{p(E|H)\ p(H)}{p(E)}$$

BAYES' THEOREM

$$p(H|E) \neq p(E|H)$$

ALL YOU NEED TO KNOW!

THE DEFENCE

"ONLY 0.1% OF THE MEN WHO ABUSE
THEIR WIVES END UP MURDERING THEM.
THE FACT THAT SIMPSON ABUSED HIS WIFE
IS IRRELEVANT TO THE CASE"

BASE RATES MATTER

THE BAYESIAN PROCESS

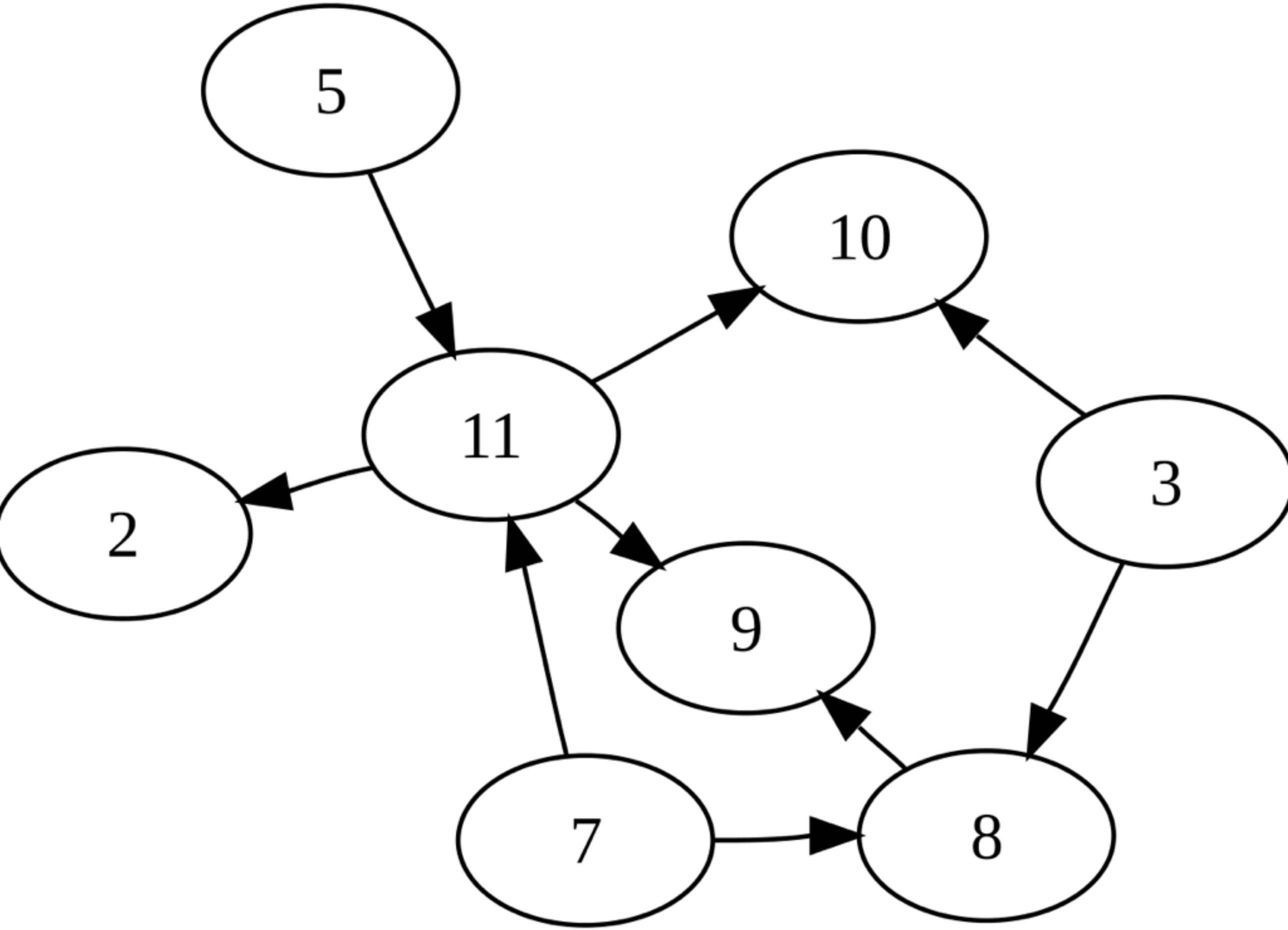
- Start with a prior belief
- Observe new evidence
- Update posterior belief based on Bayes' Rule

APPLICATIONS

BAYESIAN SEARCH

- Formulate location hypotheses.
- For each hypothesis, construct a probability density function for the location of the object.
- Construct a probability function for actually finding an object in a location when searching there if it really is in that location.
- Combine the two functions produce an overall probability density map.
- Construct a search path which starts at the point of highest probability and 'scans' over high probability areas, then intermediate probabilities, and finally low probability areas.
- Revise all the probabilities continuously during the search by applying Bayes' theorem.

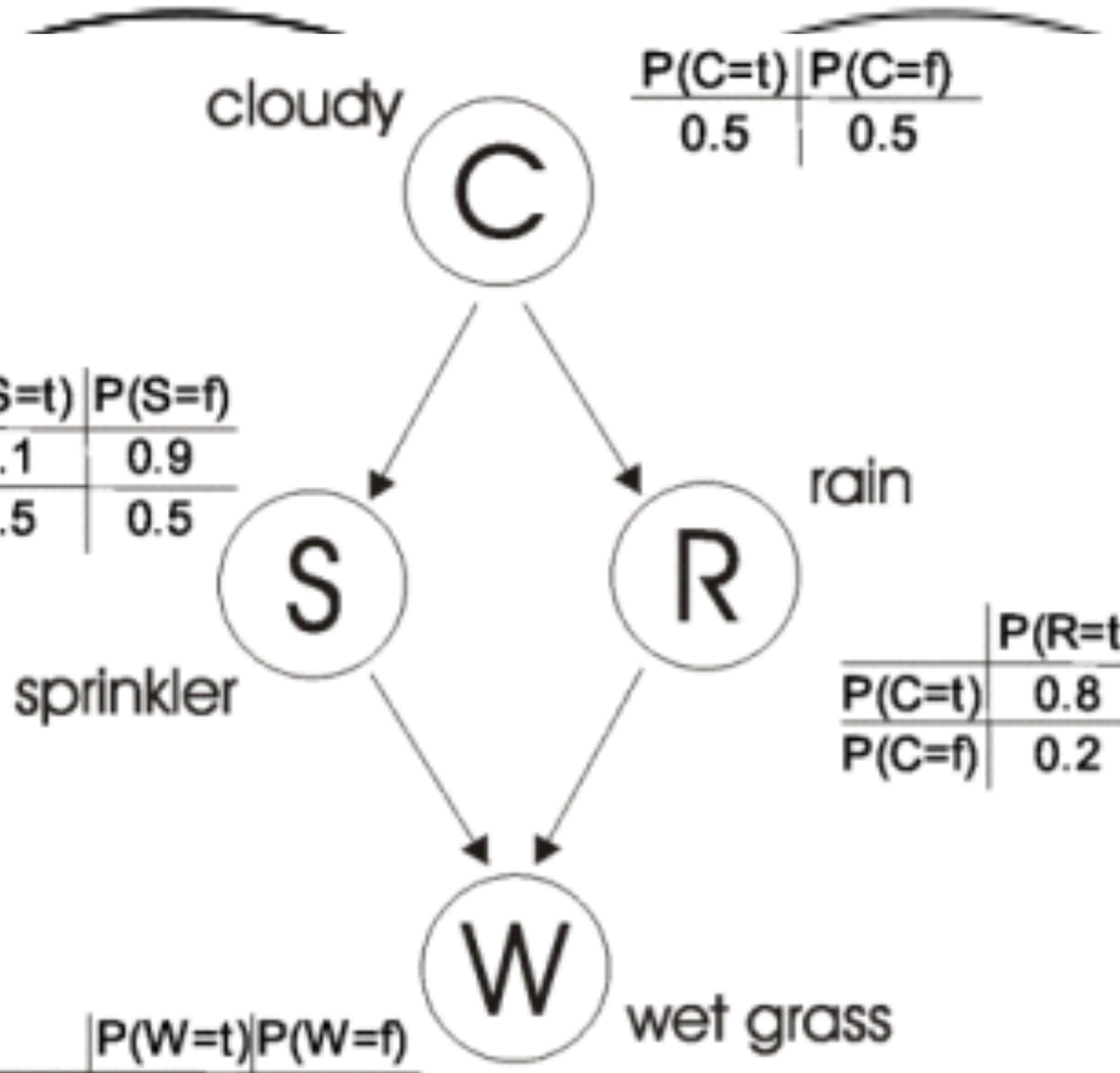
BELIEF NETWORKS


5
10
11
3
2
9
7
8

- Represents conditional dependencies between beliefs
- Each node represents a belief or state
- Each node has a conditional probability with another

SPRINKLER		
RAIN	T	F
F	0.4	0.(
T	0.01	0.9

RAIN		
T	F	
0.2	0.8	



F T 0.8 0.2

T F 0.9 0.1

T T 0.99 0.01

HTTP://WWW.RA.CS.UNI-TUEBINGEN.DE/SOFTWARE/JCELL/TUTORIAL/CH03S03.HTML

QUALIFYING BELIEF

“It strikes me as quite odd that these tubes are manufactured to a tolerance that far exceeds U.S. requirements for comparable rockets. Maybe Iraqis just manufacture their conventional weapons to a higher standard than we do, but I don't think so.”

— US SECRETARY OF STATE'S ADDRESS TO THE UNITED NATIONS SECURITY COUNCIL

“It strikes me as quite odd that these tubes are manufactured to a tolerance that far exceeds U.S. requirements for comparable rockets (p=0.21).”

QUALIFYING CLAIMS FOR INTELLIGENCE CONSUMERS

"Beliefs expressed without reference to priors or comparable hypotheses are largely meaningless."