Decision Making

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This week

Today

Reasoning about probabilities

Markov Decision Processes

Thursday

Applications for MDPs

Coursework

A problem

- The probability that somebody has a disease Q is 1% (prevalence).
- If a person has Q then the probability that they test positive is 90% (sensitivity)
- If a person does not have Q, then nevertheless they have a 9% chance of testing positive (a false positive)
- A person tests positive. What is the chance of them having the disease?

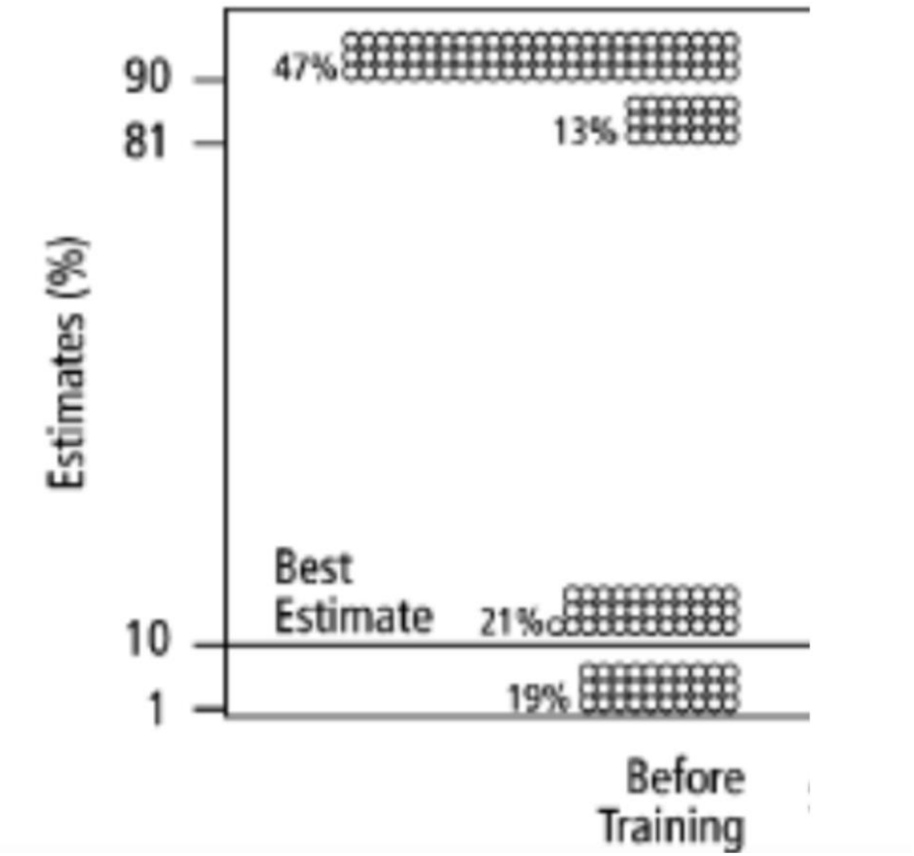
Medical Advice

- The probability that somebody has a disease Q is 1% (prevalence).
- If a person has Q then the probability that they test positive is 90% (sensitivity)
- If a person does not have Q, then nevertheless they have a 9% chance of testing positive (a false positive)
- A person tests positive.

What advice should a Medical Advice System give?

1. The probability that they have disease Q is about 81%.
2. Out of 10 people with a positive test, about 9% have disease Q.
3. Out of 10 people with a positive test, about 1 has Q.
4. The probability that they have Q is about 1%.

Gigerenzer et al. (2008)



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Natural Frequencies

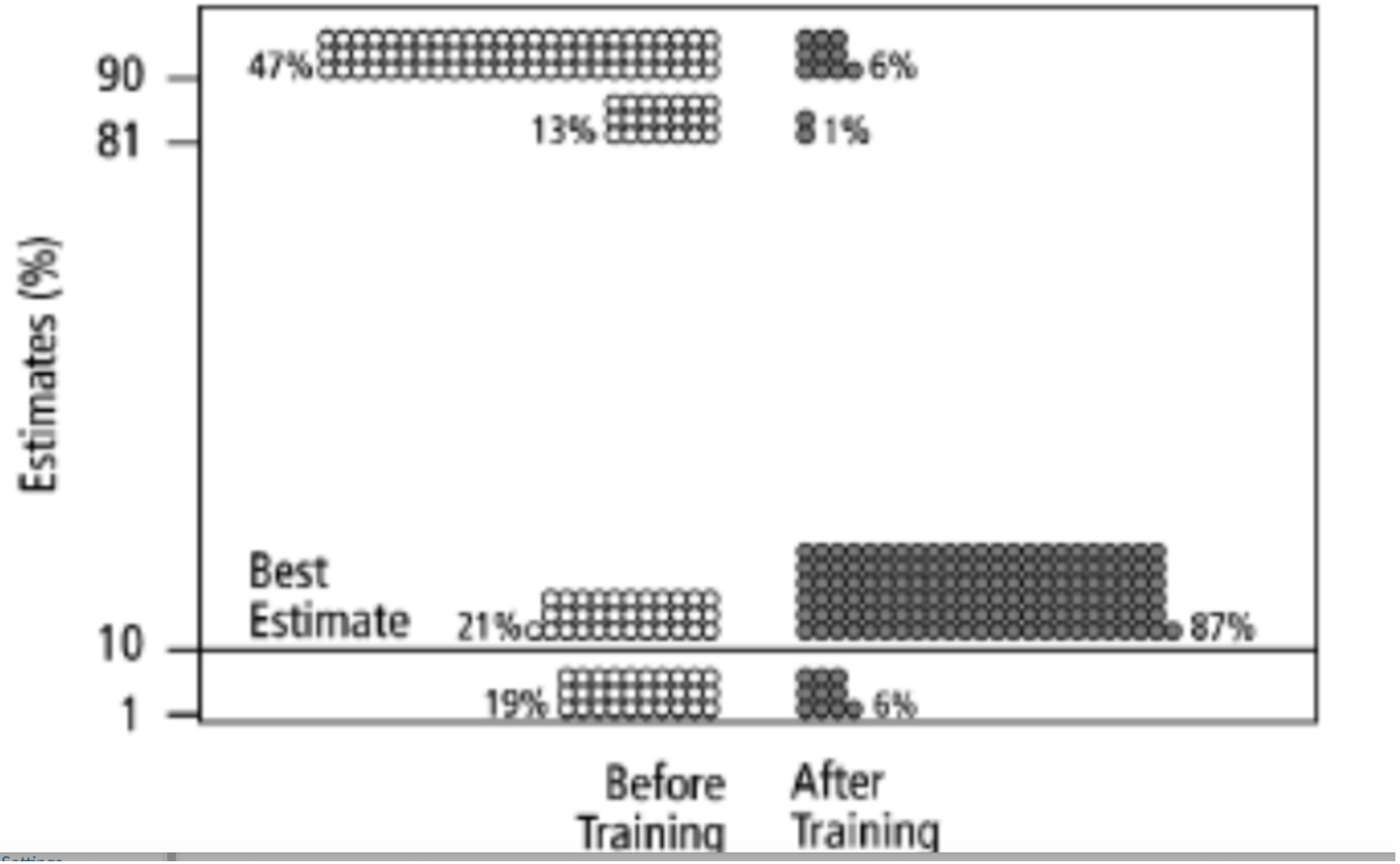
Assume you conduct screening for Q in a certain region. You know the following information about the people in this region:

Ten out of every 1,000 people have Q

Of these 10 people, 9 test positive

Of the 990 people without cancer, about 89 nevertheless test positive

After training



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Bayes' Law

$$p(\theta \mid D) = \frac{p(D \mid \theta)\, p(\theta)}{p(D)}.$$

$$\text{posterior} = \frac{\text{likelihood} \times \text{prior}}{\text{marginal likelihood}}.$$

Applied to our problem

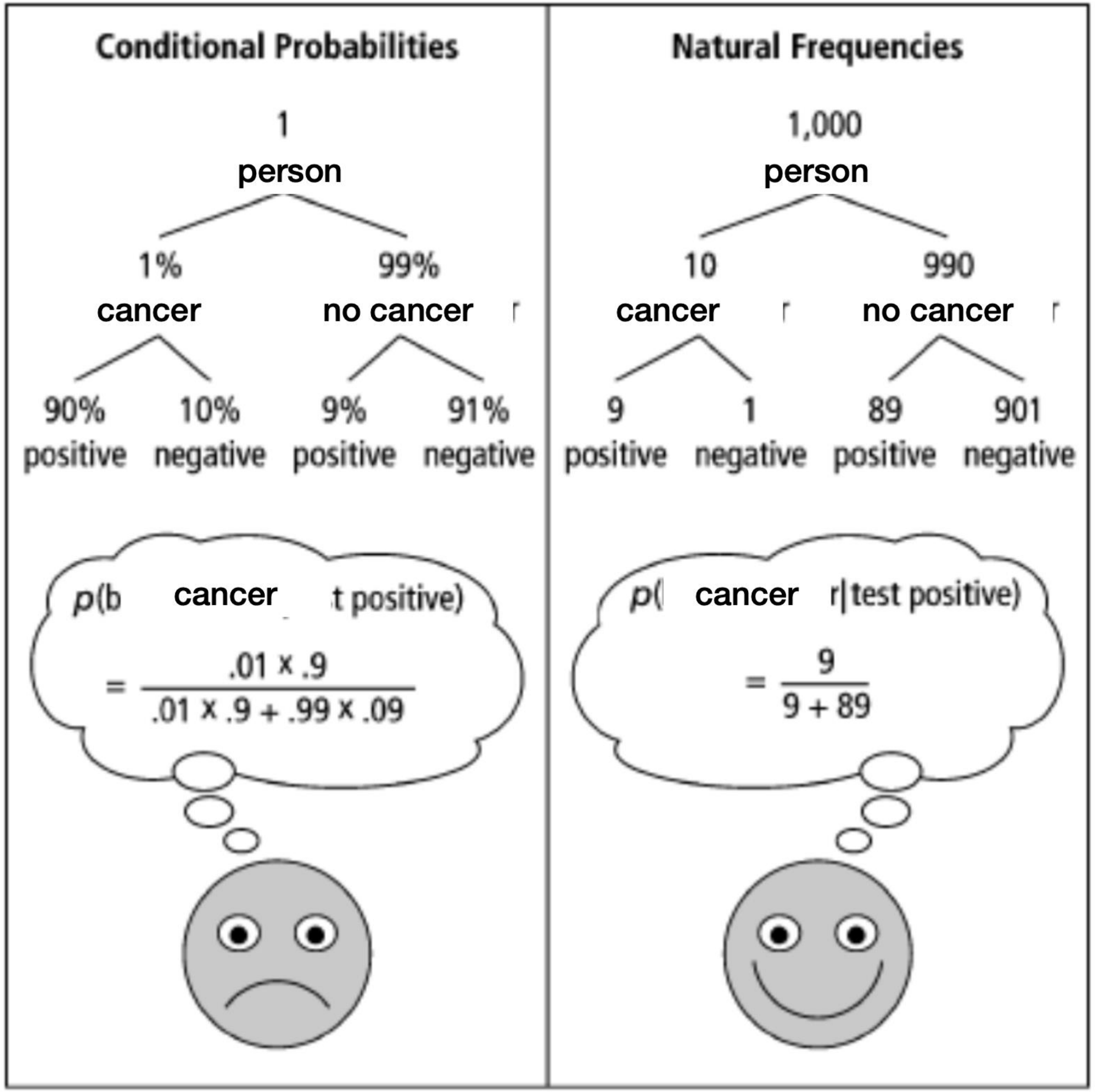
Q = has disease

T = has positive test

$$P(Q|T) = \frac{P(T|Q)P(Q)}{P(T)}$$

P(Q|T) = 0.0918

= ~9%



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Discussion

Humans appear to be poor at probabilistic reasoning.

Intelligent Interactive Systems tend to very good.

Is this fair?

How should we design IIS to provide advice & support to humans?