

Probability and Random Processes

ECS 315

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6.1 Conditional Probability



Office Hours:

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Wednesday 14:00-15:30

Friday 14:00-15:30

Suppose we have a diagnostic test for a particular disease which is 99% accurate. The test gives a positive result.



What is the probability that the person actually has the disease?

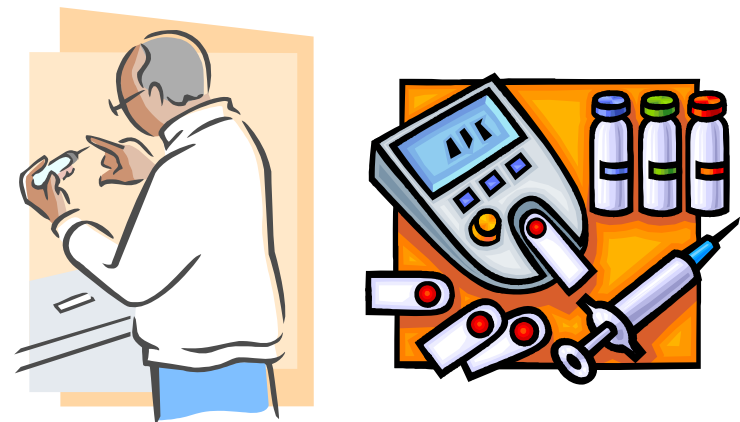


News: September 2015



Disease Testing

- Suppose we have a diagnostic test for a particular **disease** which is 99% accurate.
- A person is picked at random and tested for the disease.
- The test gives a **positive result**.
- Q1: What is the probability that the person actually has the disease?
- Natural answer: 99% because the test gets it right 99% of the times.



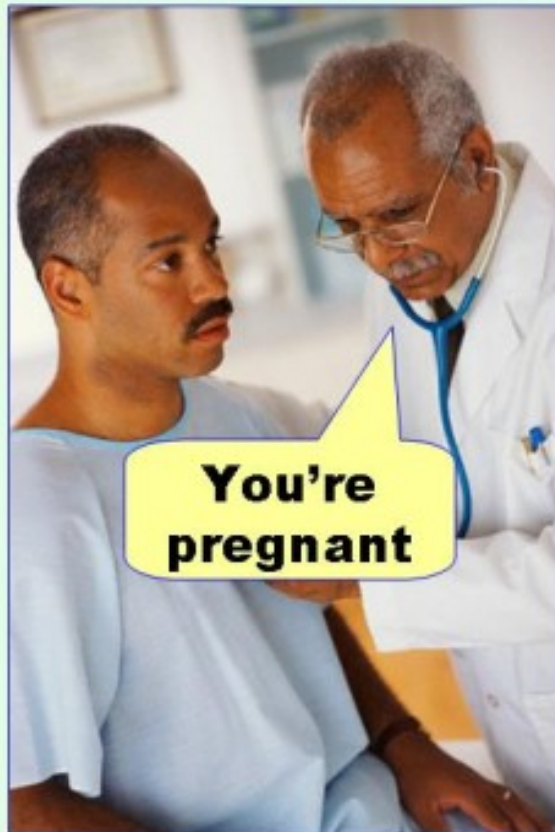
99% accurate test?

- Two kinds of error
- If you use this test on many persons **with** the disease, the test will indicate correctly that those persons have disease 99% of the time.
 - **False negative** rate = $1\% = 0.01$ 1 → 0
- If you use this test on many persons **without** the disease, the test will indicate correctly that those persons do not have disease 99% of the time.
 - **False positive** rate = $1\% = 0.01$ 0 → 1



False positive and false negative

Type I error
(false positive)



Type II error
(false negative)



Disease Testing: The Question

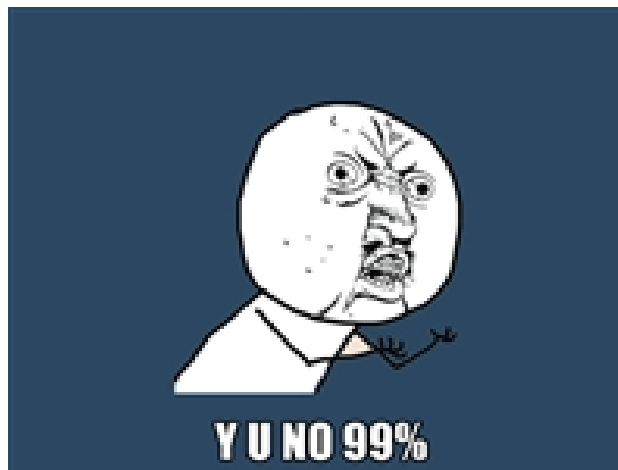
- Suppose we have a diagnostic test for a particular **disease** which is 99% accurate.
- A person is picked at random and tested for the disease.
- The test gives a **positive result**.
- Q1: What is the probability that the person actually has the disease?
- Natural answer: 99% because the test gets it right 99% of the times.
- Q2: Can the answer be 1% or 2%?
- Q3: Can the answer be 50%?



Disease Testing: The Answer

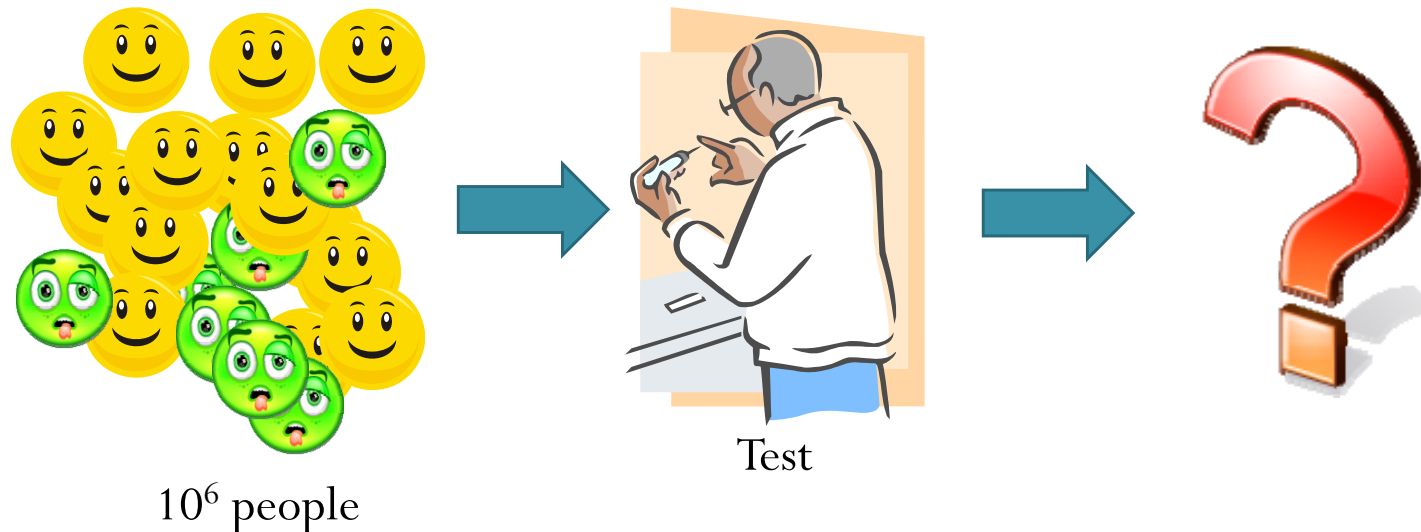
Q1: What is the probability that the person actually has the disease?

A1: The answer actually depends on how **common** or how **rare** the disease is!

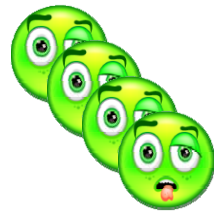


Why?

- Let's assume **rare disease**.
 - The disease affects about 1 person in 10,000.
- Try an experiment with **10^6 people**.
- Approximately **100 people** will have the disease.
- What would the (99%-accurate) test say?



Results of the test



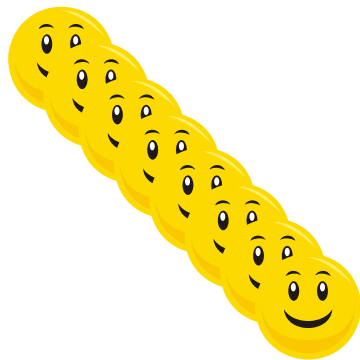
100 people w/ disease



approximately

99 of them will test positive

1 of them will test negative



999,900 people w/o disease

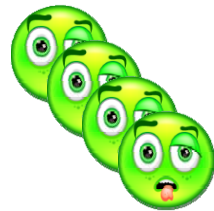


989,901 of them will test negative

9,999 of them will test positive



Results of the test

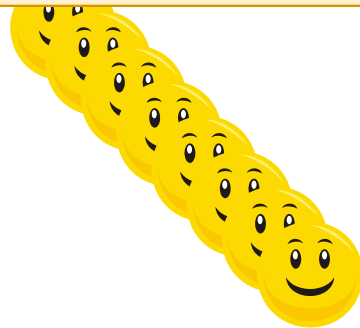
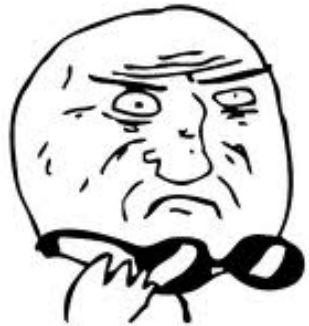


100 people w/ disease



99 of them will **test positive**
1 of them will test negative

Of those who **test positive**, only $\frac{99}{99 + 9,999} \approx 1\%$ actually have the disease!



999,900 people w/o disease



989,901 of them will test negative
9,999 of them will **test positive**

