Seeing is believing

Casting light on probability misconceptions

1. The Linda problem

Linda is 31 years old, single, outspoken, and very bright. She majored in philosophy. As a student, she was deeply concerned with issues of discrimination and social justice, and also participated in anti-nuclear demonstrations. Which is more probable?

a) Linda is a bank teller.
b) Linda is a bank teller and is active in the feminist movement.

Tversky, A., & Kahneman, D. (1983). Extensional versus intuitive reasoning: The conjunction fallacy in probability judgment. *Psychological Review, 90*(4), 293-315

2. The Taxi Problem

Two cab companies operate in a given city, the Blue and the Green (according to the colour of cab they run). 85% of the cabs in the city are Blue and the remaining 15% are Green. A cab was involved in a hit-and-run accident at night. A witness later identified the cab as a Green cab. The court tested the witness's ability to distinguish Blue and Green cabs under night-time visibility conditions. It found that the witness was able to identify each colour correctly about 80% of the time, but confused with the other colour about 20% of the time.

What do you think are the chances that the errant cab was Green, as the witness claimed?

Tversky, A., & Kahneman, D. (1982). Evidential impact of base rates. In D. Kahneman, P. Slovic, A. Tversky (Eds.), Judgment under uncertainty: Heuristics and biases: Cambridge University Press.

3. The Hospital Problem

A certain town is served by two hospitals. In the larger hospital about 45 babies are born each day, and in the smaller hospital about 15 babies are born each day.

Although the overall proportion of boys born on any day in the town is about 50%, the actual proportion at either hospital may be greater or less than 50% on any day.

At the end of the year, which hospital will have the greater number of days on which more than 60% of the babies born were boys?

a) The large hospital
b) The small hospital
c) Neither – the number of days will be about the same

Kahneman, D., & Tversky, A. (1972). Subjective probability: A judgment of representativeness. Cognitive Psychology, 3, 430-454.

4. The Mammography Problem

A patient has a positive mammogram. In the absence of any additional information, the probability that a woman of the same age and health status of this patient is 1%. If the patient has breast cancer, the probability of having a positive mammogram is 80%. If the patient does not have breast cancer, the probability of having a positive mammogram is 10%.

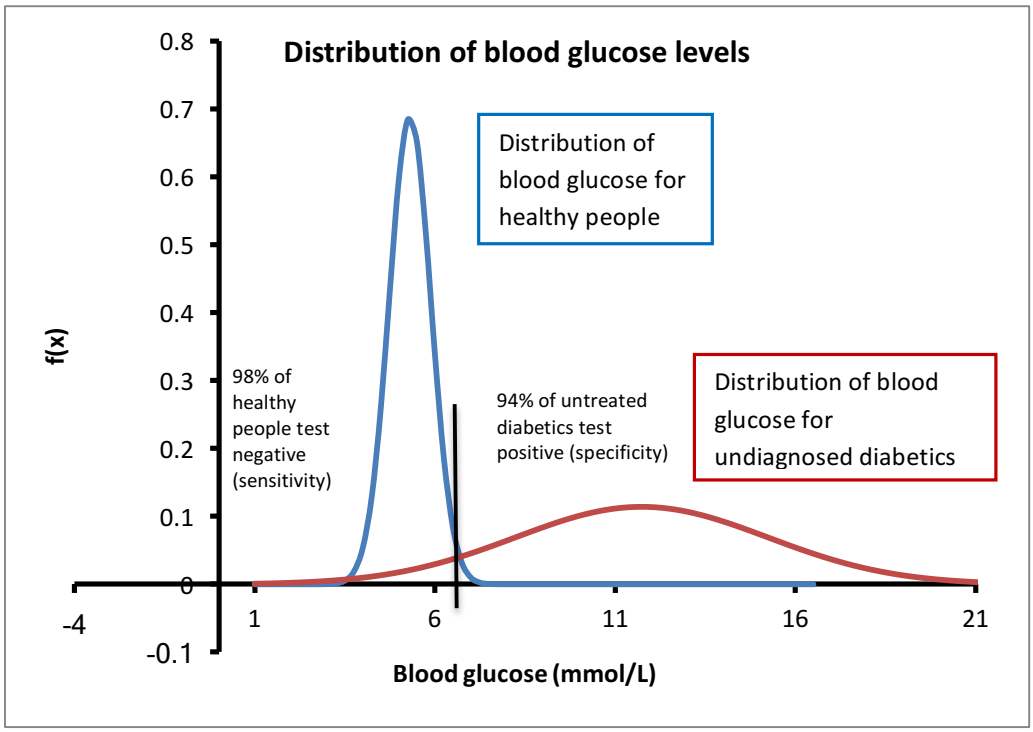
What is the probability that this patient has breast cancer?

Eddy D. M. (1982). Probabilistic reasoning in clinical medicine: problems and opportunities. In D. Kahneman, P. Slovic, A. Tversky (Eds.), Judgment under uncertainty: Heuristics and biases: Cambridge University Press.

5. Pachinkogram task

A new housing development has been built in your neighbourhood. In order to service the needs of this new community, a new health clinic has opened. As part of the health clinic's enrolment procedure, new patients are required to undergo health check-ups which include, among other things, a series of blood tests. One such test is designed to measure the amount of glucose in an individual's blood. This measurement is recorded after the individual fasts (abstains from eating) for a prescribed period of time. Fasting blood glucose levels in excess of 6.5mmol/L are deemed to be indicative of diabetes. This threshold of 6.5mmol/L works most of the time with about 94% of people who have diabetes being correctly classified as diabetics and about 98% of those not having diabetes being correctly classified as non-diabetics.

The prevalence of diabetes in the NZ population is about 7% (i.e. approximately 7% of the NZ population are estimated to have diabetes).



**Graph above taken from* Pfannkuch, Seber, & Wild, 2002.

As part of enrolment in this health clinic, an individual has a fasting blood test. He/she is told that his/her blood glucose level is higher than 6.5mmol/L. What are the chances that he/she has diabetes?

Intuitive answer:

Now use the pachinkogram to simulate the situation in order to answer the question.

Now investigate the effect of changing the base rate (i.e. the prevalence of diabetes in the population) on the answer to the question.