MATH 4280 – Hurley – homework problem – February 27, 2008

1. There is test, commonly referred to as the quadruple test, given to pregnant women during the second trimester to detect fetuses with an increased risk of Down's Syndrome, among other conditions. Those women who test positive are generally given an amniocentesis.

   When I was pregnant and my obstetrician was explaining the test, I wanted to know how worried I should be if the test were positive. So I asked him what the probability was that a positive test indicated a case of Down's Syndrome. [1] [2]

   How could I have figured out the answer to my question from the following probabilities? The overall rate of Down's syndrome is $\frac{1}{525}$. The probability that a fetus with Down's syndrome tests positive is .8068, and the probability that a fetus without Don's syndrome tests positive is .0694.[3]

   (a) What is the probability of a positive test result?

   (b) What is the probability that a positive test result is wrong, i.e., that the fetus does not have Down's syndrome?

   Explain your answers using the terminology and notation of section 4.1, i.e., regard the test as a channel and give its input and output alphabets and channel matrix etc.

[1] This is based on a true story, although I have changed some of the details to match the data that I found on-line.

[2] I must have explained my question poorly because my doctor told me that my question was not valid. I was quite insulted and resolved never to say such a thing to my students.

[3] I believe that these numbers are realistic. I found them on the web site *Bandolier*, which got them from: N.J. Wald et al. *Antenatal screening for Down's syndrome with the quadruple test.* Lancet 2003. 361: 835-836.