EE435 Spring 2012 PS03 (Problem Set 03)

Due: Fri 2/10/2012

1. Use Bayesian decision theory to determine a decision rule for the following pattern recognition problem.

   It is desired to create a system to automatically determine whether a person approaching a particular military checkpoint Afghanistan has malicious intent or not, simply based on their facial expression: whether they are smiling, frowning or have neutral facial expression. Some a priori knowledge:

   For this checkpoint, of the number of people that approach it, 8% have malicious intent.

   Of people who have malicious intent, 85% are smiling, 7% are frowning and 8% have a neutral expression.
   Of people who don't have malicious intent, 43% are smiling, 7% are frowning and 50% have a neutral expression.

   On a separate page, draw a well-labeled probability tree for this problem and answer the following questions:

   If a person approaching the checkpoint is smiling, do they have malicious intent? Why or why not?

   No $P(MI|smile) < P(NMI|smile)$
   $0.1467 \quad 0.8533$

   If a person approaching the checkpoint is frowning, do they have malicious intent? Why or why not?

   No $P(MI|frown) < P(NMI|frown)$
   $0.08 \quad 0.92$

   If a person approaching the checkpoint has a neutral expression, do they have malicious intent? Why or why not?

   NO $P(MI|neutral) < P(NMI|neutral)$
   $0.0137 \quad 0.9863$

   What is the % error you expect with your decision rule?

	% error
smile	14.67%
frown	8%
neutral	1.37%

   Does this seem like a reasonable way to determine malicious intent?

   NO- the system always will determine no malicious intent.

(Turn this page over for problem # 2)

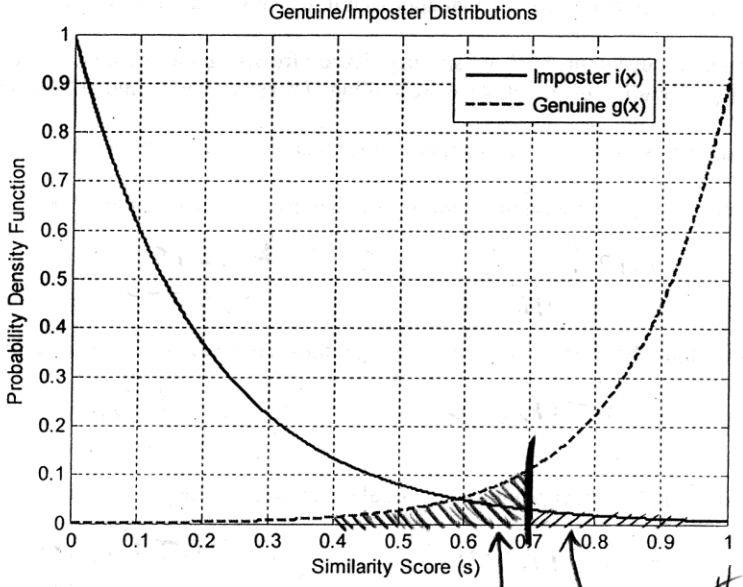
2. For a biometric recognition problem, the probability density functions of imposter and genuine scores are displayed in the following figure. For this application, the equations for the imposter and genuine probability distributions are:

$$\text{Imposter: } i(x) = \exp(-5s)$$

$$\text{Genuine: } g(x) = \frac{\exp(7s)}{1200}$$

If the threshold for recognition is set at 0.7, what is the decision rule? if $s \geq 0.7$, match otherwise, not a match

Determine the FMR and FNMR (show your work), and indicate the areas that represent FMR and FNMR on the plot below.



FNMR = this area under $g(x)$

FMR = this area under $i(x)$

FMR = 0.47 %

FNMR = 1.59 %

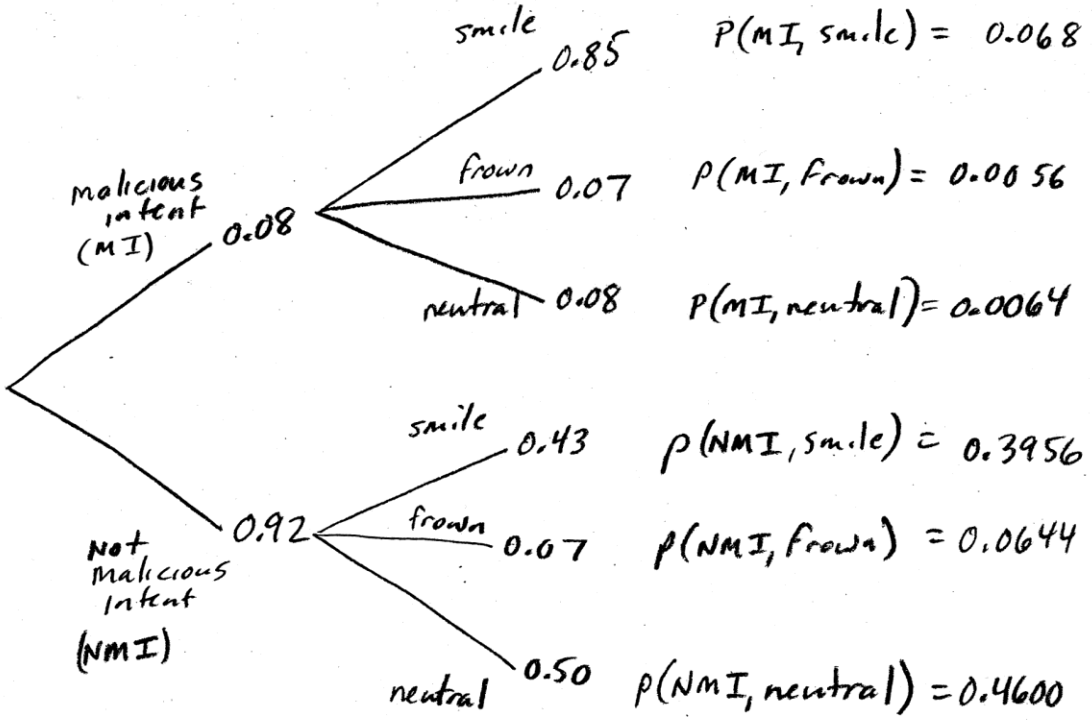
$$FMR = \int_{0.7}^{1} e^{-5s}\,ds = -\frac{1}{5}e^{-5s}\Big|_{.7}^{1.0}$$

$$= -\frac{1}{5}\left(e^{-5} - e^{-.35}\right) \approx 0.0047$$

$$FNMR = \int_{0}^{0.7} \frac{e^{7s}}{1200} = \frac{1}{7(1200)}e^{7s}\Big|_{0}^{0.7}$$

$$= \frac{1}{8400}\left(e^{0.49} - e^{0}\right) \approx 0.0159$$

Note
Since FNMR > FMR, System is more security oriented than convenience oriented.



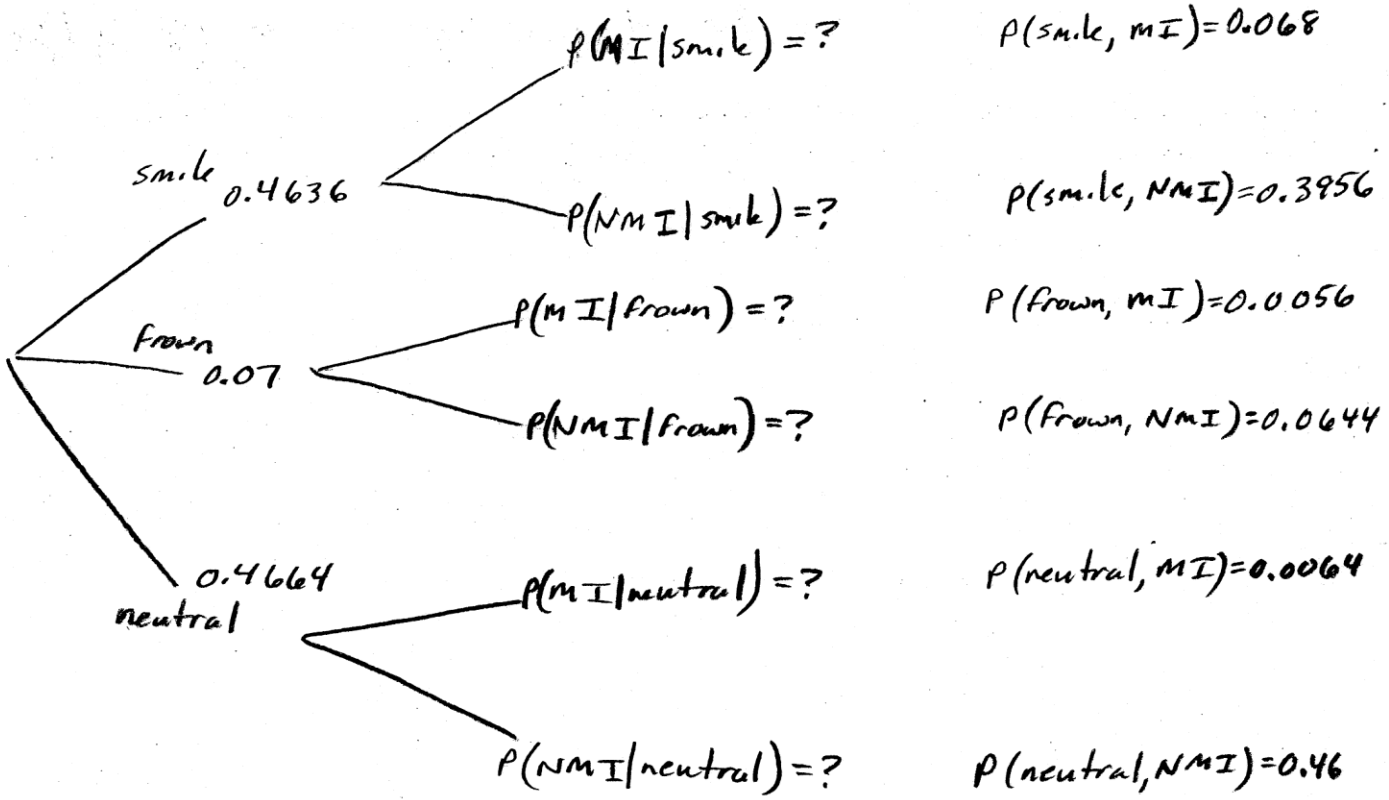
$P(\text{smiling}) = P(\text{smile}, MI) + P(\text{smile}, NMI) = 0.068 + 0.3956 = 0.4636$

$P(\text{frown}) = P(\text{frown}, MI) + P(\text{frown}, NMI) = 0.0056 + 0.0644 = 0.0700$

$P(\text{neutral}) = P(\text{neutral}, MI) + P(\text{neutral}, NMI) = 0.0064 + 0.4600 = 0.4664$

We use these values to create a new probability tree, based first on the feature value that we measure.

Note that in this tree, $P(MI, \text{smile}) = P(\text{smile}, MI)$
i.e. the probability that someone is both ~~frowning~~ smiling and has hostile intent is equal to the probability that they both have hostile intent and are smiling.



$$P(MI|smile) = \frac{P(MI, smile)}{P(smile)} = \frac{0.068}{0.4636} = 0.1467$$

$$P(MI|frown) = \frac{P(MI, frown)}{P(frown)} = \frac{0.0056}{0.0700} = 0.0800$$

$$P(MI|neutral) = \frac{P(MI, neutral)}{P(neutral)} = \frac{0.0064}{0.4664} = 0.0137$$

$$P(NMI|smile) = \frac{P(NMI, smile)}{P(smile)} = \frac{0.3956}{0.4636} = 0.8533$$

$$P(NMI|frown) = \frac{P(NMI, frown)}{P(frown)} = \frac{0.0644}{0.0700} = 0.9200$$

$$P(NMI|neutral) = \frac{P(NMI, neutral)}{P(neutral)} = \frac{0.4600}{0.4664} = 0.9863$$

These determine the decision rule