

**HW1 STT 465  
(MSU, Fall, 2015)**

Due Wednesday, Sept 13<sup>th</sup> in class.

**Topics:** marginal and conditional probability, Bayes theorem, exchangeability.

**Background.** Consider a disease controlled by a single DNA locus with two possible alleles A and B. In this setting any individual in the population can have one of the three following genotypes: AA, AB and BB.

From a large genetic epidemiology study the following are the estimated probability of disease  $p(Di=1 | G_i)$  for each of the possible genotypes

Genotype ( $G_i$ )	$p(Di=1 G_i)$
AA	0.0
AB	0.1
BB	0.9

If  $\theta$  denotes the frequency of allele A, under random mating, the genotype frequencies in the population are:  $p(AA) = \theta^2$ ,  $p(BB) = (1-\theta)^2$ ,  $p(AB) = 2\theta(1-\theta)$

**Question 1**

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In population I  $\theta=0.9$ , compute and report the prevalence of disease in population I.

**Question 2**

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An individual in population I has developed the disease, what is the probability that the genotype of that individual is AA, AB or BB?

**Question 3**

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In population II the frequency of allele A is 0.95. An individual is healthy, what is the probability that this individual comes from population I (assume that, a priori, individuals are equally likely to come from population 1 or 2).

**Question 4.**

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Provide frequencies for the joint distribution of the two Bernoulli random variables (i.e., probabilities in a 2x2 contingency table) that:

- satisfy IID (identically and independently distributed),
- satisfy exchangeability but not IID
- do not satisfy IID and are not exchangeable.

Explain your reasoning.