MATH 308 Assignment 3
Exercises 1.11

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a)

Observational study.

b)

No, because it is possible that people without dementia are predisposed to drinking alcohol.

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a)

Observational study.

b)

No, because it is likely that students who already use marijuana would be interested in listening to music that had references to marijuana.

c)

No, because the study sample was not collected in a controlled, randomized fashion. Further, it excludes students who are not in high school.

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Number of unique subsets of size N is $\binom{N}{n}$.
The number of unique subsets that include a given individual is $\binom{N-1}{n-1}$.
$\therefore$ Required probability

$$
\begin{aligned}
&= \binom{N-1}{n-1} \Big/ \binom{N}{n} \\
&= \frac{(N-1)!}{\cancel{(N-n)!}(n-1)!} \times \frac{\cancel{(N-n)!}n!}{N!} \\
&= \frac{(N-1)!}{N!} \times \frac{n!}{(n-1)!} \\
&= \frac{n}{N} \quad \square
\end{aligned}
$$

This formula does not change with the individual. Therefore, by symmetry, every person has an equal chance of being in the group. $\square$

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a)

From (5), with $N = 10^8$ and $n = 10^3$, required probability $p = n/N = 10^{-5}$.

b)

Probability of not being in any of 2000 independently chosen samples $= (1-p)^{2000} \approx 98\%$.

c)

A half-chance of being in at least one sample implies a half-chance of being in no samples. So, if t samples

are chosen,

$$\begin{aligned} & q^t = 0.5 \\ \implies \quad & t \log q = \log 0.5 \\ \implies \quad & t = \frac{\log 0.5}{\log(1 - 10^{-5})} \\ & = 69315 \end{aligned}$$