Quiz 2

URBAN 520: Quantitative Methods in Urban Design and Planning

Time: 30 minutes | Total: 20 points | November 03, 2026 | Name: _____

The American Community Survey is the U.S. Census Bureau's annual survey of how people live, including housing costs, income, and commuting, as well as whether they rent or own. Answering it is required by law. We will use it as the context today, and there are some formulas that may be helpful.

Formula Sheet

Bayes' rule

$$P(B \mid A) = \frac{P(A \mid B)\,P(B)}{P(A)} = \frac{P(A \mid B)\,P(B)}{P(A \mid B)\,P(B) + P(A \mid B^c)\,P(B^c)}$$

Discrete Random Variable

$$\mu = E[X] = \sum_x x\,p(x), \quad \sigma^2 = \mathrm{Var}(X) = \sum_x (x-\mu)^2 p(x)$$

Binomial, $X \sim \mathrm{Bin}(n, p)$

$$P(X = k) = \binom{n}{k} p^k (1-p)^{n-k}, \quad k = 0, 1, \ldots, n, \quad \binom{n}{k} = \frac{n!}{k!\,(n-k)!}$$

$$E[X] = np, \quad \mathrm{Var}(X) = np(1-p), \quad \mathrm{SD}(X) = \sqrt{np(1-p)}$$

Normal, $X \sim N(\mu, \sigma^2)$

$$f(x) = \frac{1}{\sigma\sqrt{2\pi}} \exp\left(-\frac{(x-\mu)^2}{2\sigma^2}\right), \quad E[X] = \mu, \quad \mathrm{Var}(X) = \sigma^2$$

$$Z = \frac{X - \mu}{\sigma} \sim N(0, 1)$$

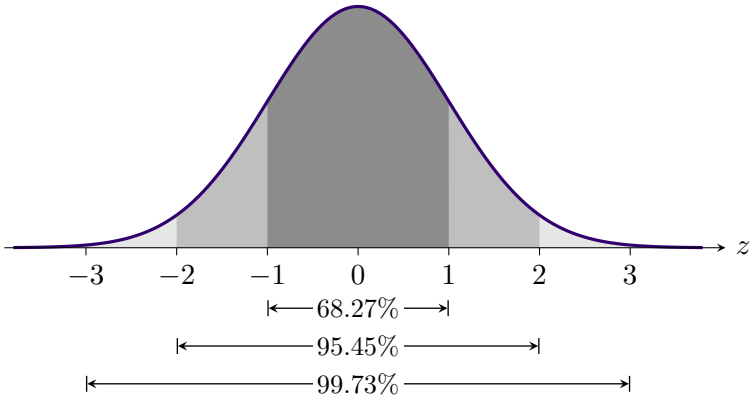


Figure 1: The standard normal distribution $N(0, 1)$.

Sample Mean

$$E[\bar{X}] = \mu, \quad \mathrm{SE} = \mathrm{SD}(\bar{X}) = \frac{\sigma}{\sqrt{n}}$$

Question 1 True or False (4 points)

No explanation needed for these questions.

A. (1 point) If renting and having no car were independent, the share of renters among no-car households would equal the share of renters among all households. _____

B. (1 point) Because of the empirical (68-95-99.7) rule, about 68% of King County households have incomes within one SD of the mean income. _____

C. (1 point) A city's online housing survey answered by 5,000 residents gives a more reliable estimate of the citywide renter share than a random sample of 1,500 households, because it is larger.

_____

D. (1 point) Household incomes are strongly right-skewed. Even so, if we drew many random samples of 2,000 households, the sample mean incomes would be approximately normally distributed.

_____

Question 2 Short Answer (16 points)

These questions should be answered briefly (in a few sentences).

A. (4 points) Each year, the American Community Survey (ACS) will sample 3.5 million addresses from its list of all addresses in the country. Selected households can answer online or by mail. But if the households do not answer, about 1/3 will be visited by a Census interviewer. Before any interviewer visits, 45% of renter households and 70% of owner households answer the ACS online or by mail in a city. We also know that 40% of households rent in this city. Among the households that answer online or by mail, what share rent?

B. (4 points) On average, every address has a 2.5% probability of being selected for the ACS in any given year, and no address is selected more than once in five years.

1. An address was selected in 2024. What is the probability that it is selected in 2025? Are "selected in 2024" and "selected in 2025" independent?
2. Is the probability that an address is selected at least once during these five years (2021–2025) equal to $1 - (39/40)^5$, the way we computed the chance of at least one flood? Why?

C. (4 points) In a tract, 40% of households rent. The ACS collects answers from 150 randomly selected households in the tract. Let X be the number of renter households among them.

1. What distribution does X follow? Give its expected value and standard deviation.
2. About 95% of possible samples would contain how many renter households? And why?

D. (4 points) The Bureau publishes 1-year estimates for places with at least 65,000 people, and 5-year estimates for all areas down to neighborhoods. Using $SE = \sigma/\sqrt{n}$, explain why a 5-year estimate is more precise than a 1-year estimate for the same census tract.