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## Stats / Chebyshev's theorem and the empirical rule

Problem Explanation

### Chebyshev's theorem and the empirical rule

#### QUESTION

A real estate company is interested in the ages of home buyers. They examined the ages of thousands of home buyers and found that the mean age was 42 years old, with a standard deviation of 10 years. Suppose that these measures are valid for the population of all home buyers. Complete the following statements about the distribution of all ages of home buyers.

- (a) According to Chebyshev's theorem, at least  of the home buyers' ages lie between 27 years and 57 years.
- (b) According to Chebyshev's theorem, at least  of the home buyers' ages lie between 22 years and 62 years.
- (c) Suppose that the distribution is bell-shaped. According to the empirical rule, approximately  of the home buyers' ages lie between 22 years and 62 years.
- (d) Suppose that the distribution is bell-shaped. According to the empirical rule, approximately 99.7% of the home buyers' ages lie between  years and  years.

**General Note:** The additional information that the distribution is bell-shaped allows stronger statements about the percentage of home buyers' ages that lie within a certain distance of the mean. In particular, knowing that the distribution is bell-shaped allows us to upgrade the statement

"at least 75% of the home buyers' ages lie between 22 and 62,"

which is what we obtained from Chebyshev's theorem in part (b), to the statement

"approximately 95% of the home buyers' ages lie between 22 and 62,"

which is what we obtained from the empirical rule in part (c).

$$Z = \frac{x - \mu}{\sigma}$$

data value - mean  
standard deviation

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$$\text{Chebyshev's } \left[100\left(1 - \frac{1}{k^2}\right)\right]\%$$

$$\textcircled{a} \quad \frac{27-42}{10} = \frac{-15}{10} = -1.5 \quad \frac{57-42}{10} = \frac{15}{10} = 1.5$$

$$k = 1.5$$

$$\left[100\left(1 - \frac{1}{1.5^2}\right)\right]\% = \left[100(0.555)\right]\% = 55.5\%$$

$$\textcircled{b} \quad \frac{22-42}{10} = \frac{-20}{10} = -2 \quad \frac{62-42}{10} = \frac{20}{10} = 2$$

$$k = 2$$

$$\left[100\left(1 - \frac{1}{2^2}\right)\right]\% = \left[100(0.75)\right]\% = 75\%$$

(Subtract 10 from  $\mu$ )  $\mu$   $\sigma = 10$  (Add 10 to  $\mu$ )

