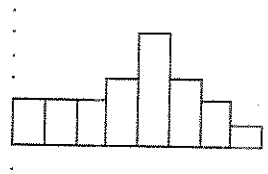
1) A coffee vending machine dispenses coffee into a paper cup. You're supposed to get 10 ounces of coffee, but the amount varies slightly from cup to cup. Here are the amounts measured in a random sample of 20 cups. Is there evidence that the machine is shortchanging customers?

9.9	9.7	10.0	10.1
9.9	9.6	9.8	9.8
10.0	9.5	9.7	10.1
9.9	9.6	10.2	9.8
10.0	9.9	9.5	9.9

Hypotheses: $H_0: \mu = 10.0 \quad H_a: \mu < 10.0$

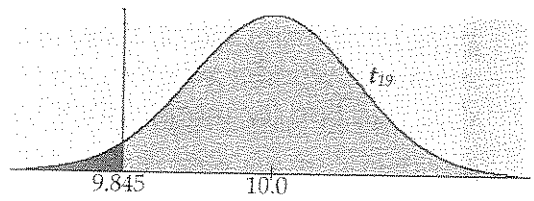
Plan: Random sample; 20 < 10% of all cups. The histogram of sample data looks roughly unimodal and symmetric, so it's reasonable to believe that the amount of coffee in all possible cups could be described by a Normal model. Okay to do a *t*-test for the mean.



Mechanics: $n = 20 \quad df = 19 \quad \bar{x} = 9.845 \quad s = 0.199$

$$t = \frac{9.845 - 10}{0.199/\sqrt{20}} = -3.49$$

$$P = P(t_{19} < -3.49) = 0.0012$$



Conclusion: Such a small P-value makes it unlikely that the low sample mean resulted from sampling error, so we reject the null hypothesis. There is strong evidence that the mean amount of coffee dispensed by this machine is less than the stated 10 fluid ounces.

Confidence interval: The conditions have been met, so we can create a one-sample *t*-interval. (Note that all confidence intervals look alike: estimate ± margin of error)

$$\bar{x} \pm t^*_{19} \cdot SE(\bar{x}) = 9.845 \pm 2.093\frac{0.199}{\sqrt{20}} = (9.75, 9.94)$$

We are 95% confident that the machine dispenses an average of between 9.75 and 9.94 fluid ounces of coffee per cup.