HW # 8: Due Tues 10/29 by 11:59pm ET

Graded

59 Minutes Late

Student

Ivan Wang

Total Points

11 / 15 pts

Question 1

Problem 1

4 / 5 pts

- ✔ **− 0.5 pts** part (b): you're using $\overline{s}$ rather than $\frac{\overline{s}}{c_4}$ in your calculation (but somehow still end up with the correct ratio).
- ✔ **− 0.5 pts** part (c): not exactly clear what "exact" capability is "better" than C_p means. Both suggest many defectives, which is the connection that should be made here.

Question 2

Problem 2

7 / 10 pts

- ✔ **− 1 pt** part (d): missing the "exact" capability, which requires you to compute the probability $P(16 < X < 16.1)$. Note that the one-sided ratios C_{pk} have not been discussed yet.
- ✔ **− 2 pts** parts (a)-(b): your Minitab charts are using $L = 3$ rather than $L = 3.09$, which is why your computed limits are different than the Minitab limits.

Question assigned to the following page: 1

Problem 1. Suppose 20 random samples of size n = 5 were collected from some normally distributed process. The data is contained in columns G through K in the `hw_data.xlsx` file. The process mean μ and the process standard deviation σ are assumed to be unknown.

(a) Estimate the process standard deviation using the s -bar method. Use this estimate in part(b) below.

(a) $\hat{\sigma} = \dfrac{\bar{s}}{c_4}$ $\quad n = 5$

$c_4 = 0.9400$

$\bar{s} = 16.6345$ from minitab

$$\boxed{\hat{\sigma} = 17.6962766}$$

(b) Determine the process capability ratio if the specification limits are 129 ± 25.

Question assigned to the following page: 1

b) $C_p = \frac{USL - LSL}{6\sigma}$

129 ± 25

$USL = 154$

$LSL = 104$

$$C_p = \frac{154 - 104}{6(17.69627766)} = \frac{50}{106.1776596}$$

$$= 0.470908854$$

(c) What does the process capability ratio suggest about the number of defective items produced by this process? How does this compare with the exact process capability computed in Problem 1(d) of Homework # 7?

Question assigned to the following page: 1

c) Since $C_p = 0.470908854 < 1$, the $\mu \pm 3\sigma$ interval is wider than the specification interval, resulting in many defectives

- The exact process capability computed in Problem 1 d is

$P(104 \leq X \leq 154) = 0.8395$

$0.8348 < 1$, still lacks capability but is better than C_p of 0.47070908854

Problem 2. A factory produces items that are supposed to weigh 16 ounces. Weights for 25 randomly selected items were obtained, and appear in columns Q through R in the `hw_data.xlsx` file. The process is assumed to be normally distributed with unknown mean and standard deviation.

Question assigned to the following page: 2

(a) Use the appropriate formulas to compute the center line and the control limits for the individuals control chart using $\alpha = 0.002$. Then use Minitab to create this control chart (include the chart, and make sure your computed limits agree with Minitab's).

Question assigned to the following page: 2

$$UCL = \bar{X} + Z_{\alpha/2} \cdot \frac{\overline{MR}}{d_2}$$

$$CL = \bar{X}$$

$$LCL = \bar{X} - Z_{\alpha/2} \cdot \frac{\overline{MR}}{d_2}$$

$$Z_{\alpha/2} = Z_{0.005} = 3.090$$

$$n = 2, \quad d_2 = 1.128$$

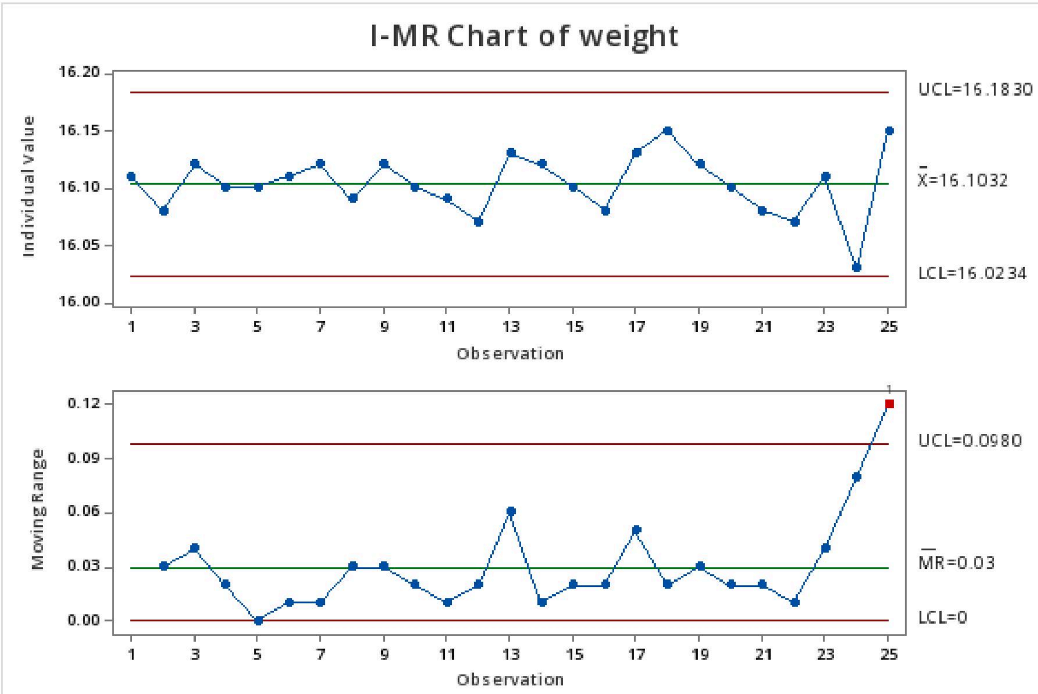
$$\bar{X} = 16.1032$$

$$\overline{MR} = 0.03$$

$$UCL = 16.18538085$$

$$CL = 16.1032$$

Question assigned to the following page: 2



(b) Use the appropriate formulas to compute the center line and the control limits for the moving range control chart using α = 0.002. Then use Minitab to create this control chart (include the chart, and make sure your computed limits agree with Minitab's).

Question assigned to the following page: 2

$$UCL = \overline{MR} + Z_{\alpha/2} \cdot d_3 \frac{\overline{MR}}{d_2}$$

$$CL = \overline{MR}$$

$$LCL = \overline{MR} - Z_{\alpha/2} \cdot d_3 \cdot \frac{\overline{MR}}{d_2}$$

$\overline{MR} = 0.03$ $\quad n = 2$

$Z_{\alpha/2} = 3.090$

$d_2 = 1.128$

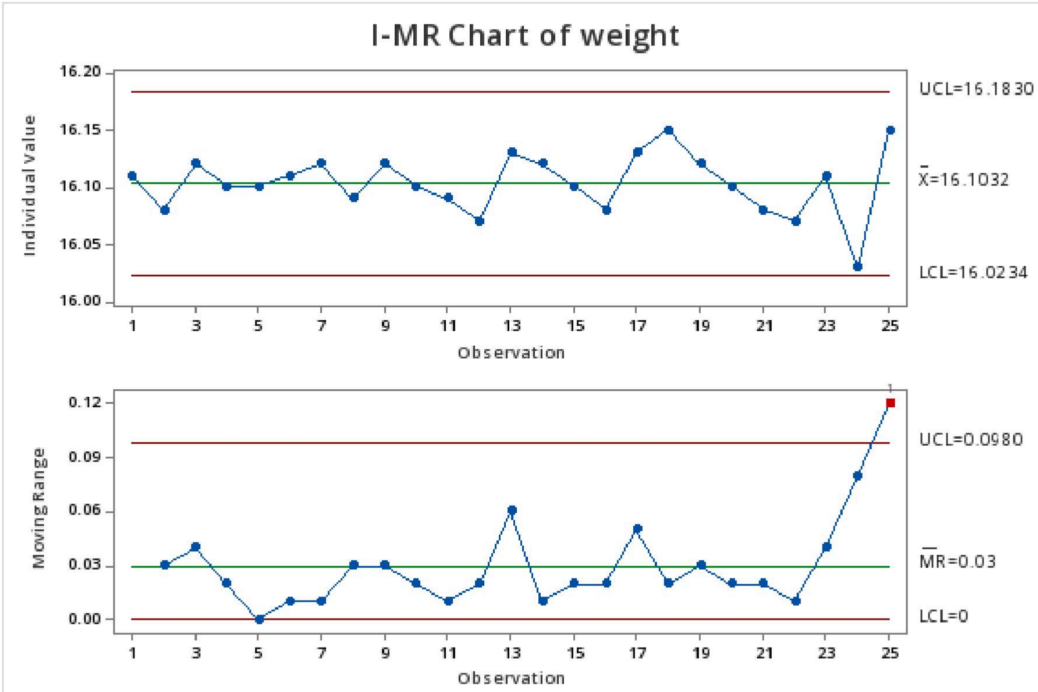
$d_3 = 0.853$

$UCL = 0.100100266$

$CL = 0.03$

$LCL = -0.040100266 \Rightarrow 0$

Question assigned to the following page: 2



(c) Estimate the process mean, and then estimate the process standard deviation using $\sigma = MR/d_2$. You will use these estimates in part (d) below.

Question assigned to the following page: 2

estimate process mean, $\hat{\mu} = \bar{X}$

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process standard deviation, $\hat{\sigma} = \dfrac{\overline{MR}}{d_2}$

$\hat{\mu} = 16.1032$

$\hat{\sigma} = 0.0265957447$

(d) Underweight items are more problematic than overweight items, so the manufacturer sets the specifi-cation limits at 16.05 ± 0.05 ounces. Determine the exact process capability and the process capability ratio.

$$C_p = \frac{USL - LSL}{6\sigma}$$

$$C_p = \frac{16.10 - 16}{6(0.0265957447)} = 0.625$$

$$P(16 \leq X \leq 16.1)$$

$$C_{pk} = \min\left(\frac{USL - \bar{X}}{3\sigma}, \frac{\bar{X} - LSL}{3\sigma}\right)$$

upper: $\frac{USL - \bar{X}}{3\sigma} = \frac{16.10 - 16.1032}{3(0.0265957447)} = -0.0401$

lower: $\frac{LSL - \bar{X}}{3\sigma} = \frac{16 - 16.1032}{3(0.026595744)} = 1.294$

$$C_{pk} = -0.0401$$