Formative Assessment 4

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https://github.com/chieelo/STATS/tree/d5fb88cf2743867df820d5468d01029b673d2665/FA4_GROUP3_BORROMEO_MAY

The normal data are female height measurements, the skewed-right data are age at marriage for females, the skewed-left data are obituary data that give the age at death for females, and the uniform data are the amount of cola put into a 12 ounce container by a soft drinks machine.

```
library(knitr)

data <- read.csv("Data-1.csv")
kable(data)
```

Normal	SK_right	SK_left	Uniform
67	31	102	12.1
70	43	55	12.1
63	30	70	12.4
65	30	95	12.1
68	38	73	12.1
60	26	79	12.2
70	29	60	12.2
64	55	73	12.2
69	46	89	11.9
61	26	85	12.2
66	29	72	12.3
65	57	92	12.3
71	34	76	11.7
62	34	93	12.3
66	36	76	12.3
68	40	97	12.4
64	28	10	12.4
67	26	70	12.1
62	66	85	12.4
66	63	25	12.4
65	30	83	12.5
63	33	58	11.8
66	24	10	12.5
65	35	92	12.5
63	34	82	12.5

Normal	SK_right	SK_left	Uniform
69	40	87	11.6
62	24	104	11.6
67	29	75	12.0
59	24	80	11.6
66	27	66	11.6
65	35	93	11.7
63	33	90	12.3
65	75	84	11.7
60	38	73	11.7
67	34	98	11.7
64	85	79	11.8
68	29	35	12.5
61	40	71	11.8
69	41	90	11.8
65	35	71	11.8
62	26	63	11.9
67	34	58	11.9
70	19	82	11.9
64	23	72	12.2
63	28	93	11.9
68	26	44	12.0
64	31	65	11.9
65	25	77	12.0
61	22	81	12.0
66	28	77	12.0

Functions to use:

```
origin_moments <- function(x, k) mean(x^k)

mean_moments <- function(x, k) {
  mu <- mean(x)
  mean((x - mu)^k)
}

moment_about_mean <- function(x, k, c) mean((x - c)^k)
```

1. Find the (a) first, (b) second, (c) third, and (d) fourth moments for each of the sets of data (normal, skewed-right, skewed-left, uniform).

```
origin_results <- sapply(1:4, function(k) c(
  Normal        = origin_moments(data$Normal, k),
  Skewed_Right  = origin_moments(data$SK_right, k),
  Skewed_Left   = origin_moments(data$SK_left, k),
  Uniform       = origin_moments(data$Uniform, k)
))

origin_df <- as.data.frame(t(origin_results))
```

```r
rownames(origin_df) <- c("1st", "2nd", "3rd", "4th")

kable(origin_df, digits = 3,
      caption = "Moments for each of the sets of data")
```

Table 2: Moments for each of the sets of data

	Normal	Skewed_Right	Skewed_Left	Uniform
1st	65.12	35.48	74.2	12.056
2nd	4248.92	1437.72	5925.4	145.426
3rd	277770.92	68292.44	489458.8	1755.158
4th	18194173.64	3797594.04	41396161.5	21194.593

2. Find the (a) first, (b) second, (c) third, and (d) fourth moments about the mean for each of the sets of data (normal, skewed-right, skewed-left, uniform).

```r
mean_result <- sapply(1:4, function(k) c(
  Normal        = mean_moments(data$Normal, k),
  Skewed_Right  = mean_moments(data$SK_right, k),
  Skewed_Left   = mean_moments(data$SK_left, k),
  Uniform       = mean_moments(data$Uniform, k)
))

mean_df <- as.data.frame(t(mean_result))
rownames(mean_df) <- c("1st", "2nd", "3rd", "4th")

kable(mean_df, digits = 5,
      caption = "Moments about the mean for each of the sets of data ")
```

Table 3: Moments about the mean for each of the sets of data

	Normal	Skewed_Right	Skewed_Left	Uniform
1st	0.00000	0.0000	0.00	0.00000
2nd	8.30560	178.8896	419.76	0.07886
3rd	-0.47174	4588.1284	-12498.26	0.00034
4th	160.94863	210642.8834	927289.75	0.01125

3. Find the (a) first, (b) second, (c) third, and (d) fourth moments about the number 75 for the set of female height measurements.

```r
moments75 <- sapply(1:4, function(k) moment_about_mean(data$Normal, k, 75))

moments75_df <- data.frame(
  Moment = c("1st", "2nd", "3rd", "4th"),
  Value  = round(moments75, 2)
)

kable(moments75_df, caption = "Moments about the number 75 for the set of female height measurements")
```

Table 4: Moments about the number 75 for the set of female height measurements

Moment	Value
1st	-9.88
2nd	105.92
3rd	-1211.08
4th	14572.64

4. Using the results of items 2 and 3 for the set of female height measurements, verify the relations between the moments

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(a)

$$m_2 = m_2' - (m_1')^2$$

(b)

$$m_3 = m_3' - 3m_2'm_1' + 2(m_1')^3$$

(c)

$$m_4 = m_4' - 4m_3'm_1' + 6m_2'(m_1')^2 - 3(m_1')^4$$

```
# about origin
m1p <- origin_moments(data$Normal, 1)
m2p <- origin_moments(data$Normal, 2)
m3p <- origin_moments(data$Normal, 3)
m4p <- origin_moments(data$Normal, 4)

# about mean
m2 <- mean_moments(data$Normal, 2)
m3 <- mean_moments(data$Normal, 3)
m4 <- mean_moments(data$Normal, 4)


m2_relation <- m2p - m1p^2
m3_relation <- m3p - 3*m2p*m1p + 2*(m1p^3)
m4_relation <- m4p - 4*m3p*m1p + 6*m2p*(m1p^2) - 3*(m1p^4)


moment_tab <- data.frame(
  Moment   = c("m2", "m3", "m4"),
  Actual   = c(m2, m3, m4),
  Relation = c(m2_relation, m3_relation, m4_relation)
)

kable(moment_tab, digits = 4,
      caption = "Relations between the moments")
```

Table 5: Relations between the moments

Moment	Actual	Relation
m2	8.3056	8.3056
m3	-0.4717	-0.4717
m4	160.9486	160.9486