```python
import pandas as pd
import matplotlib.pyplot as plt
import seaborn as sns
import numpy as np
from google.colab import files
import io
from IPython.display import display, Markdown


# I. FILE LOADING (ACTION REQUIRED)
print("ACTION REQUIRED: Please click 'Choose Files' and select your
file.")
uploaded = files.upload()

try:
    file_name = list(uploaded.keys())[0]
    df = pd.read_csv(io.BytesIO(uploaded[file_name]))
    print(f"\n Successfully loaded file: {file_name}\n")
except Exception as e:
    print(f"\n An error occurred during file reading: {e}")
    raise


# II. MOMENT CALCULATION FUNCTIONS

def moment_about_origin(series, n):
    """Calculates the n-th moment about the origin (raw moment)."""
    return (series ** n).mean()

def moment_about_mean(series, n):
    """Calculates the n-th moment about the mean (central moment)."""
    if n == 1:
        return (series - series.mean()).mean() # Should be zero
    return ((series - series.mean()) ** n).mean()

def moment_about_a(series, n, a):
    """Calculates the n-th moment about a specific point 'a'."""
    return ((series - a) ** n).mean()


# III. ANSWERS TO NEW MOMENTS QUESTIONS (1, 2, 3)

# --- Q1: Moments About the Origin (Raw Moments) ---
raw_moments = {
    f'{n}th Moment (Raw)': df.apply(moment_about_origin, n=n) for n in
range(1, 5)
}
raw_moments_df = pd.DataFrame(raw_moments).T.round(2)

print("----------------------------------------------------------------
```

```
-")
print("QUESTION 1: Moments about the Origin (Raw Moments).")
print("ANSWER:")
display(raw_moments_df)

# --- Q2: Moments About the Mean (Central Moments) ---
central_moments = {
    f'{n}th Moment (Central)': df.apply(moment_about_mean, n=n) for n
in range(1, 5)
}
central_moments_df = pd.DataFrame(central_moments).T.round(2)

print("----------------------------------------------------------------
-")
print("QUESTION 2: Moments about the Mean (Central Moments).")
print("ANSWER:")
display(central_moments_df)

# --- Q3: Moments About 75 for SK_left ---
# Assuming 'SK_left' is the 'female height measurements' set.
a = 75
moments_about_75 = {
    f'{n}th Moment about 75': moment_about_a(df['SK_left'], n=n, a=a)
for n in range(1, 5)
}
moments_75_df = pd.DataFrame(moments_about_75,
index=['SK_left']).T.round(2)

print("----------------------------------------------------------------
-")
print("QUESTION 3: Moments about the number 75 for the set of female
height measurements. (Inferred Set).")
print("ANSWER:")
display(moments_75_df)

# IV. ANSWER TO Q4: Skewness and Kurtosis Coefficients
# (Using the calculated central moments)

# Use the calculated central moments (mu_2, mu_3, mu_4) from the
central_moments_df
mu2 = central_moments_df.loc['2th Moment (Central)']
mu3 = central_moments_df.loc['3th Moment (Central)']
mu4 = central_moments_df.loc['4th Moment (Central)']

# Calculate Skewness (alpha_3) and Kurtosis (alpha_4)
# Skewness: alpha_3 = mu_3 / (mu_2)^(3/2)
# Kurtosis: alpha_4 = mu_4 / (mu_2)^2 (Pearson's Kurtosis)
skewness_coeff = (mu3 / (mu2 ** 1.5)).round(2)
kurtosis_coeff = (mu4 / (mu2 ** 2)).round(2) # This is Pearson's
Kurtosis (raw)
```

```python
# Fisher's Kurtosis (excess kurtosis): alpha_4 - 3
fisher_kurtosis = (kurtosis_coeff - 3).round(2)

coeffs_df = pd.DataFrame({
    'Skewness Coefficient': skewness_coeff,
    "Kurtosis (Pearson's)": kurtosis_coeff,
    "Kurtosis (Fisher's / Excess)": fisher_kurtosis
}).T

print("-----------------------------------------------------------------
-")
print("QUESTION 4: Skewness and Kurtosis Coefficients (Standardized
Moments).")
print("ANSWER:")
display(coeffs_df)
print("-----------------------------------------------------------------
-\n")


# V. VISUALIZATION (Retained from previous steps)

print("\n--- VISUALIZATION OUTPUT ---")

# FIGURE 1: Normal vs. Skewed Right
fig1, axes1 = plt.subplots(1, 2, figsize=(14, 5))
fig1.suptitle('Figure 1: Comparison of Normal and Skewed Right
Distributions', fontsize=16, fontweight='bold', y=1.05)
distributions1 = [
    ('Normal', 'Normal Distribution (Symmetric)', 'peru'),
    ('SK_right', 'Skewed Right (Positive Skew)', 'darkgreen')
]

for i, (col, title, color) in enumerate(distributions1):
    sns.histplot(df[col], kde=True, ax=axes1[i], color=color,
edgecolor='black', bins=10)
    mean_val = df[col].mean()
    axes1[i].axvline(mean_val, color='red', linestyle='--',
linewidth=2, label=f'Mean: {mean_val:.2f}')
    axes1[i].set_title(title, fontsize=14)
    axes1[i].legend(loc='upper right')

plt.tight_layout()
plt.show()

# FIGURE 2: Skewed Left vs. Uniform
fig2, axes2 = plt.subplots(1, 2, figsize=(14, 5))
fig2.suptitle('Figure 2: Comparison of Skewed Left and Uniform
Distributions', fontsize=16, fontweight='bold', y=1.05)
distributions2 = [
```

```
    ('SK_left', 'Skewed Left (Negative Skew)', 'darkblue'),
    ('Uniform', 'Uniform Distribution (Flat)', 'b')
]

for i, (col, title, color) in enumerate(distributions2):
    sns.histplot(df[col], kde=True, ax=axes2[i], color=color,
edgecolor='black', bins=10)
    mean_val = df[col].mean()
    axes2[i].axvline(mean_val, color='red', linestyle='--',
linewidth=2, label=f'Mean: {mean_val:.2f}')
    axes2[i].set_title(title, fontsize=14)
    axes2[i].set_xlabel(f'{col} Values', fontsize=12)
    axes2[i].legend(loc='upper right')

plt.tight_layout()
plt.show()
```

```
ACTION REQUIRED: Please click 'Choose Files' and select your file.
```

```
<IPython.core.display.HTML object>
```

```
Saving Data-1.csv to Data-1 (4).csv
```

```
 Successfully loaded file: Data-1 (4).csv
```

```
----------------------------------------------------------------------
QUESTION 1: Moments about the Origin (Raw Moments).
ANSWER:
```


```
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[\n          4248.92,\n          18194173.64,\n          65.12\n
],\n        \"semantic_type\": \"\",\n        \"description\": \"\"\n
}\n    },\n    {\n      \"column\": \"SK_right\",\n
\"properties\": {\n        \"dtype\": \"number\",\n        \"std\":
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3797594.04,\n        \"num_unique_values\": 4,\n        \"samples\":
[\n          1437.72,\n          3797594.04,\n          35.48\n
],\n        \"semantic_type\": \"\",\n        \"description\": \"\"\n
}\n    },\n    {\n      \"column\": \"SK_left\",\n
\"properties\": {\n        \"dtype\": \"number\",\n        \"std\":
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41396161.48,\n        \"num_unique_values\": 4,\n        \"samples\":
[\n          5925.4,\n          41396161.48,\n          74.2\
n        ],\n        \"semantic_type\": \"\",\n
\"description\": \"\"\n      }\n    },\n    {\n      \"column\":
\"Uniform\",\n      \"properties\": {\n        \"dtype\": \"number\",\
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```

\"max\": 21194.59,\n   \"num_unique_values\": 4,\n
\"samples\": [\n   145.43,\n   21194.59,\n
12.06\n   ],\n   \"semantic_type\": \"\",\n
\"description\": \"\"\n   }\n   }\n]\
n}","type":"dataframe","variable_name":"raw_moments_df"}

QUESTION 2: Moments about the Mean (Central Moments).
ANSWER:

{"summary":"{\n \"name\": \"central_moments_df\",\n \"rows\": 4,\n
\"fields\": [\n   {\n   \"column\": \"Normal\",\n
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n   \"num_unique_values\": 4,\n   \"samples\": [\n
8.31,\n   160.95,\n   -0.0\n   ],\n
\"semantic_type\": \"\",\n   \"description\": \"\"\n   }\
n   },\n   {\n   \"column\": \"SK_right\",\n   \"properties\":
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104548.47293436174,\n   \"min\": 0.0,\n   \"max\":
210642.88,\n   \"num_unique_values\": 4,\n   \"samples\": [\
n   178.89,\n   210642.88,\n   0.0\n   ],\n
\"semantic_type\": \"\",\n   \"description\": \"\"\n   }\
n   },\n   {\n   \"column\": \"SK_left\",\n   \"properties\":
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\"semantic_type\": \"\",\n   \"description\": \"\"\n   }\
n   },\n   {\n   \"column\": \"Uniform\",\n   \"properties\":
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0.038622100754188225,\n   \"min\": 0.0,\n   \"max\": 0.08,\n
\"num_unique_values\": 3,\n   \"samples\": [\n   -0.0,\n
0.08,\n   0.01\n   ],\n   \"semantic_type\": \"\",\n
\"description\": \"\"\n   }\n   }\n]\
n}","type":"dataframe","variable_name":"central_moments_df"}

QUESTION 3: Moments about the number 75 for the set of female height measurements. (Inferred Set).
ANSWER:

{"summary":"{\n \"name\": \"moments_75_df\",\n \"rows\": 4,\n
\"fields\": [\n   {\n   \"column\": \"SK_left\",\n
\"properties\": {\n   \"dtype\": \"number\",\n   \"std\":
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968896.48,\n   \"num_unique_values\": 4,\n   \"samples\": [\
n   420.4,\n   968896.48,\n   -0.8\n   ],\n
\"semantic_type\": \"\",\n   \"description\": \"\"\n   }\
n   }\n]\n}","type":"dataframe","variable_name":"moments_75_df"}

```
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QUESTION 4: Skewness and Kurtosis Coefficients (Standardized Moments).
ANSWER:
```


```
{"summary":"{\n  \"name\": \"coeffs_df\",\n  \"rows\": 3,\n
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\"num_unique_values\": 3,\n        \"samples\": [\n          -0.02,\n
2.33,\n          -0.67\n        ],\n        \"semantic_type\": \"\",\n
\"description\": \"\"\n      }\n    },\n    {\n      \"column\":
\"SK_right\",\n      \"properties\": {\n        \"dtype\":
\"number\",\n        \"std\": 2.361891897046377,\n        \"min\":
1.92,\n        \"max\": 6.58,\n        \"num_unique_values\": 3,\n
\"samples\": [\n          1.92,\n          6.58,\n          3.58\n
],\n        \"semantic_type\": \"\",\n        \"description\": \"\"\n
}\n    },\n    {\n      \"column\": \"SK_left\",\n
\"properties\": {\n        \"dtype\": \"number\",\n        \"std\":
3.3612547260410555,\n        \"min\": -1.45,\n        \"max\": 5.26,\n
\"num_unique_values\": 3,\n        \"samples\": [\n          -1.45,\n
5.26,\n          2.26\n        ],\n        \"semantic_type\": \"\",\n
\"description\": \"\"\n      }\n    },\n    {\n      \"column\":
\"Uniform\",\n      \"properties\": {\n        \"dtype\": \"number\",\
n        \"std\": 1.5003999466808842,\n        \"min\": -1.44,\n
\"max\": 1.56,\n        \"num_unique_values\": 3,\n
\"samples\": [\n          0.0,\n          1.56,\n          -1.44\n
],\n        \"semantic_type\": \"\",\n        \"description\": \"\"\n
}\n    }\n  ]\n}","type":"dataframe","variable_name":"coeffs_df"}
```


```
----------------------------------------------------------------------


--- VISUALIZATION OUTPUT ---
```

Figure 1: Comparison of Normal and Skewed Right Distributions

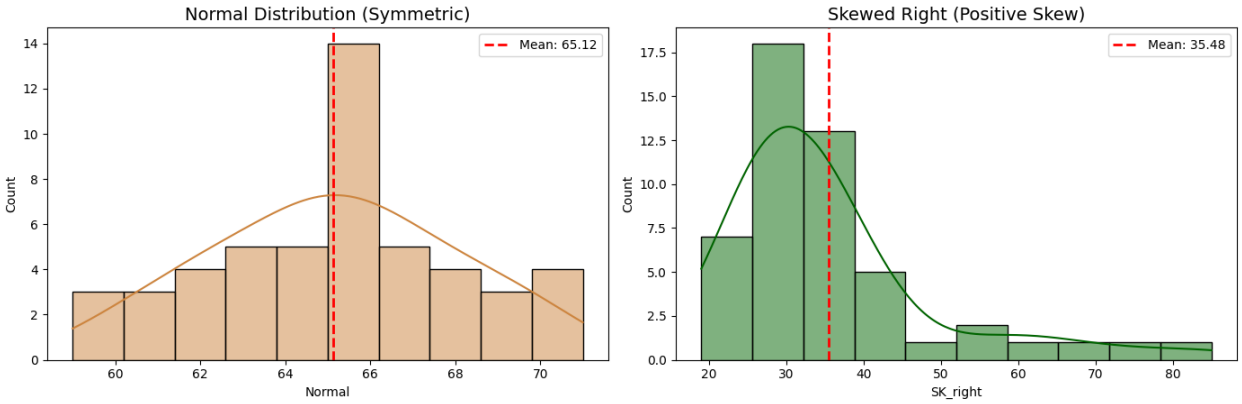

Figure 2: Comparison of Skewed Left and Uniform Distributions