GreenComputing_TP1

October 29, 2025

[2]:
```
import pandas as pd
import matplotlib.pyplot as plt
import seaborn as sns
import plotly.express as px

# Optional: improve aesthetics
sns.set(style='whitegrid')
```

[3]:
```
df = pd.read_csv('ai_model_kpi_data2.csv')
df.head()
```

[3]:

	Ques_ID_Prompt	Model	Model_Category	Question_Category	\
0	1	Gemma 3nb	Small	Easy Factual	
1	1	Llama 3.1 8b	Small	Easy Factual	
2	1	Mistral Small	Medium	Easy Factual	
3	1	GPT 20 OSS	Medium	Easy Factual	
4	1	GPT 5	Large	Easy Factual	

	Answer_Rating_0_5	Electricity_consumption_Wh	CO2_Emission_gm	\
0	4	0.19	0.12	
1	5	9.00	6.00	
2	4	0.77	0.44	
3	5	0.37	0.23	
4	5	1.52	0.93	

	Inference_Timing_sec
0	1.9
1	3.0
2	2.8
3	2.5
4	12.0

[5]:
```
df.rename(columns={
    'Ques_ID_Prompt': 'Question_ID',
    'Answer_Rating_0_5': 'Rating',
    'Electricity_consumption_Wh': 'Electricity_Wh',
    'CO2_Emission_gm': 'CO2_g',
    'Inference_Timing_sec': 'Inference_s'
```

```
}, inplace=True)

# Ensure correct data types
# df['Question_ID_Prompt'] = df['Question_ID_Prompt'].astype(int)
# df['Model'] = df['Model'].astype(str)

# # Optional: highlight math questions
# df['Is_Math'] = df['Question_ID'].isin([2, 7])  # example math question IDs
```

[6]:
```
import plotly.express as px

fig = px.scatter(
    df,
    x='Electricity_Wh',
    y='Rating',
    color='Model_Category',
    symbol='Question_Category',
    hover_data=['Model', 'CO2_g', 'Inference_s'],
    title='Quality vs Energy by Model and Question Category'
)
fig.show()
```

[7]:
```
fig = px.scatter(
    df,
    x='CO2_g',
    y='Rating',
    color='Model_Category',
    symbol='Question_Category',
    hover_data=['Model', 'Electricity_Wh', 'Inference_s'],
    title='Quality vs Carbon Emission by Category'
)
fig.show()
```

[8]:
```
fig = px.box(
    df,
    x='Model_Category',
    y='Inference_s',
    color='Model_Category',
    title='Latency Distribution by Model Category'
)
fig.show()
```

0.0.1 4. Best Trade-Off Table (Grouped by Model Category

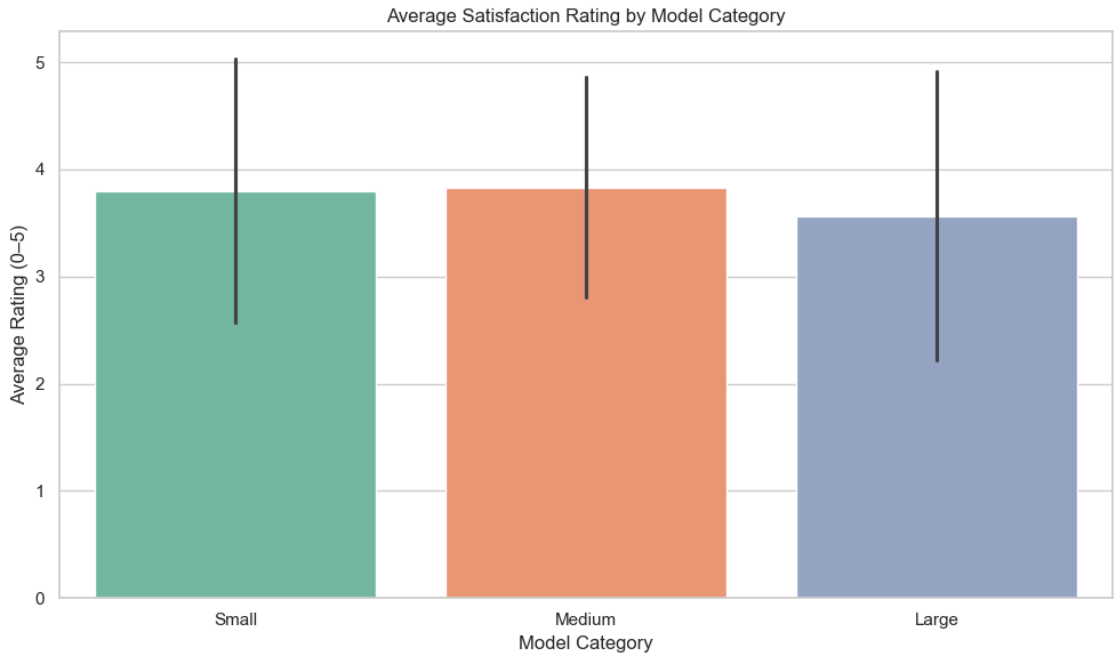
[9]:
```
df['Score'] = (
    df['Rating'] * 2
    - df['Electricity_Wh'] * 0.5
    - df['CO2_g'] * 0.5
    - df['Inference_s'] * 0.2
).round(2)

tradeoff_table = df.groupby(['Model_Category', 'Model']).agg({
    'Rating': 'mean',
    'Electricity_Wh': 'mean',
    'CO2_g': 'mean',
    'Inference_s': 'mean',
    'Score': 'mean'
}).round(2).sort_values(by='Score', ascending=False)

tradeoff_table.reset_index(inplace=True)
tradeoff_table
```

[9]:

	Model_Category	Model	Rating	Electricity_Wh	CO2_g	Inference_s	Score
0	Medium	Mistral Small	3.90	2.24	1.34	5.73	4.86
1	Small	Gemma 3nb	3.93	1.78	1.43	8.87	4.49
2	Medium	GPT 20 OSS	3.77	2.77	1.72	6.73	3.94
3	Small	Llama 3.1 8b	3.67	5.80	3.77	8.45	0.86
4	Large	GPT 5	3.33	35.16	24.86	29.18	-29.18
5	Large	DeepSeek R1	3.80	57.40	33.07	27.90	-43.21

[10]:
```
import seaborn as sns
import matplotlib.pyplot as plt

plt.figure(figsize=(10, 6))
sns.barplot(data=df, x='Model_Category', y='Rating', estimator='mean', ci='sd',␣
 ↪palette='Set2')
plt.title('Average Satisfaction Rating by Model Category')
plt.ylabel('Average Rating (0-5)')
plt.xlabel('Model Category')
plt.tight_layout()
plt.show()
```

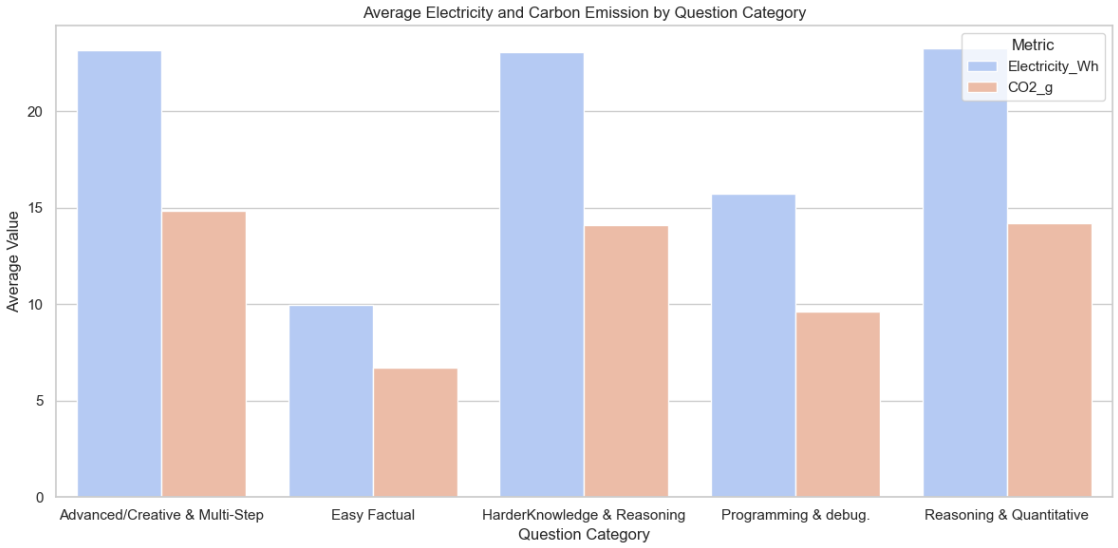
```
C:\Users\Gaurav Chugh\AppData\Local\Temp\ipykernel_59616\3230649521.py:5:
FutureWarning:


The `ci` parameter is deprecated. Use `errorbar='sd'` for the same effect.

C:\Users\Gaurav Chugh\AppData\Local\Temp\ipykernel_59616\3230649521.py:5:
FutureWarning:


Passing `palette` without assigning `hue` is deprecated and will be removed in
v0.14.0. Assign the `x` variable to `hue` and set `legend=False` for the same
effect.
```



0.0.2 2. Grouped Bar Chart — Energy & Carbon by Question Category

[11]:
```
agg = df.groupby('Question_Category')[['Electricity_Wh', 'CO2_g']].mean().
↪reset_index()
agg_melted = agg.melt(id_vars='Question_Category', var_name='Metric',␣
↪value_name='Average')
```

```
plt.figure(figsize=(12, 6))
sns.barplot(data=agg_melted, x='Question_Category', y='Average', hue='Metric',␣
 ↪palette='coolwarm')
plt.title('Average Electricity and Carbon Emission by Question Category')
plt.ylabel('Average Value')
plt.xlabel('Question Category')
plt.tight_layout()
plt.show()
```



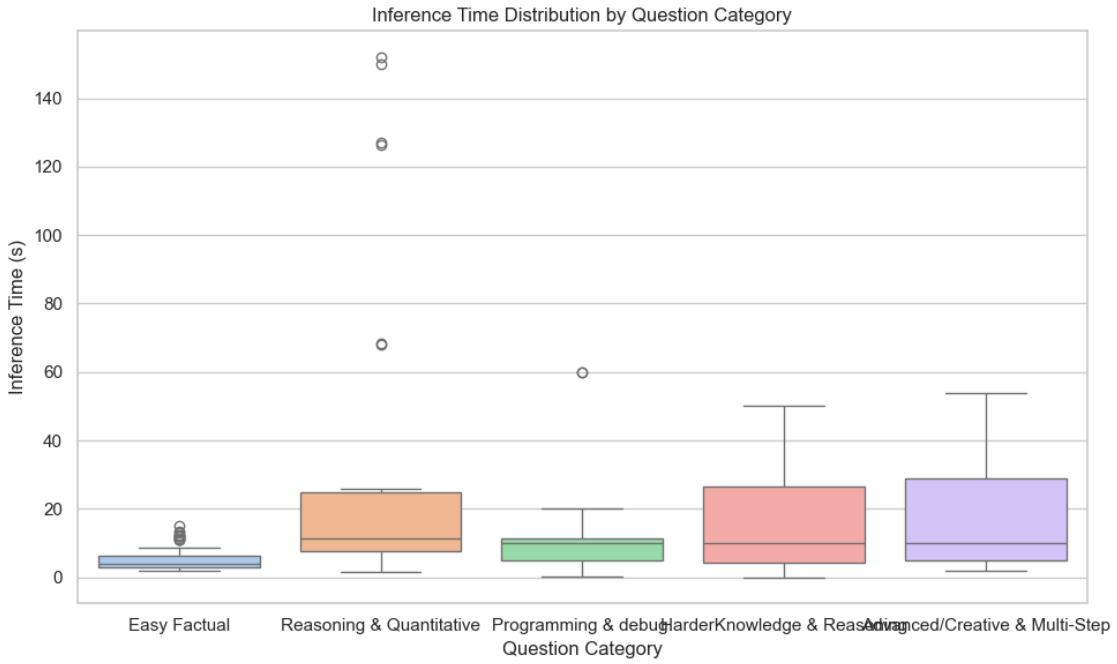
0.0.3 3. Box Plot — Inference Time by Question Category

- Box plots reveal distribution, median, and outliers.
- Helps you spot which question types cause latency spikes.

[12]:
```
plt.figure(figsize=(10, 6))
sns.boxplot(data=df, x='Question_Category', y='Inference_s', palette='pastel')
plt.title('Inference Time Distribution by Question Category')
plt.ylabel('Inference Time (s)')
plt.xlabel('Question Category')
plt.tight_layout()
plt.show()
```

```
C:\Users\Gaurav Chugh\AppData\Local\Temp\ipykernel_59616\2325750637.py:2:
FutureWarning:


Passing `palette` without assigning `hue` is deprecated and will be removed in
```

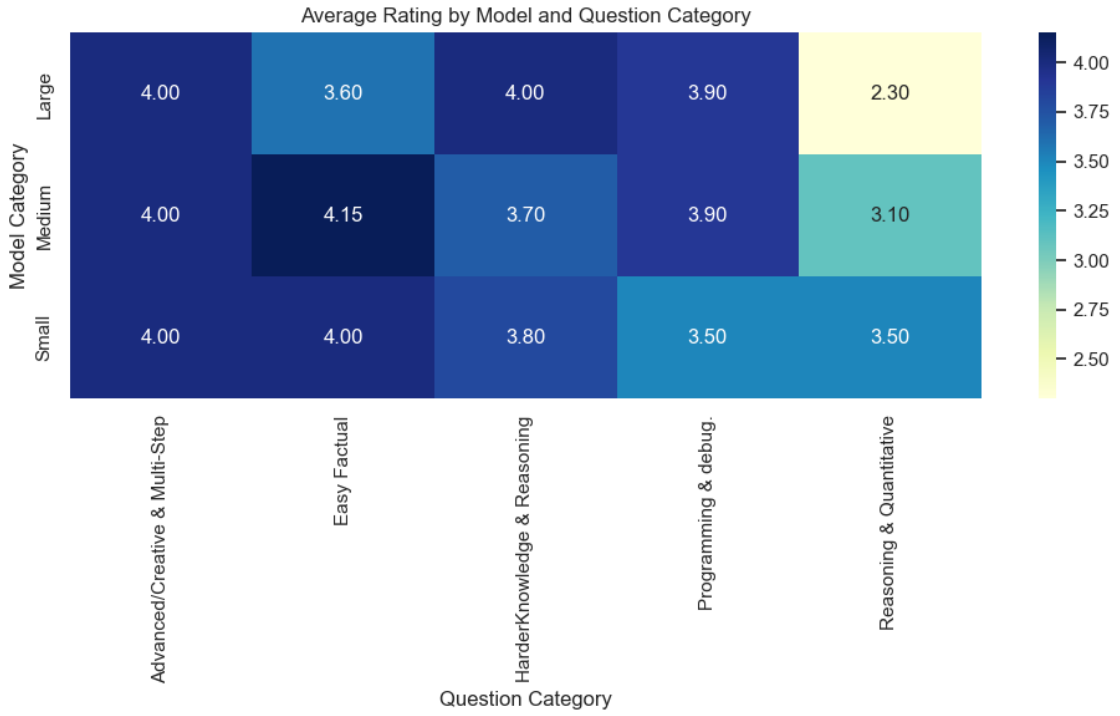
```
v0.14.0. Assign the `x` variable to `hue` and set `legend=False` for the same
effect.
```



0.0.4 4. Heatmap — KPI Averages by Model vs Question Category

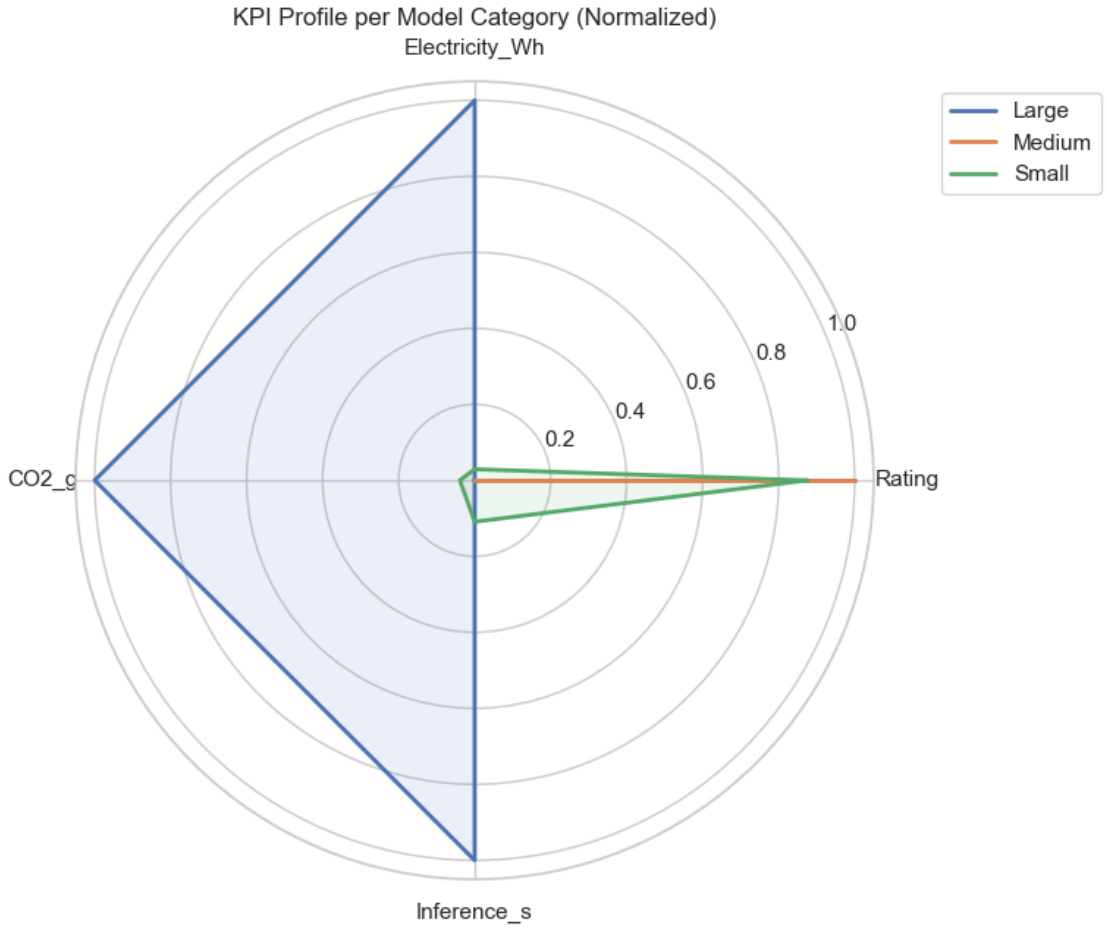
- Heatmaps are excellent for cross-dimensional comparisons.
- You can instantly see which model-question combinations perform best.

[13]:
```
pivot = df.pivot_table(index='Model_Category', columns='Question_Category',␣
↪values='Rating', aggfunc='mean')

plt.figure(figsize=(10, 6))
sns.heatmap(pivot, annot=True, cmap='YlGnBu', fmt=".2f")
plt.title('Average Rating by Model and Question Category')
plt.xlabel('Question Category')
plt.ylabel('Model Category')
plt.tight_layout()
plt.show()
```



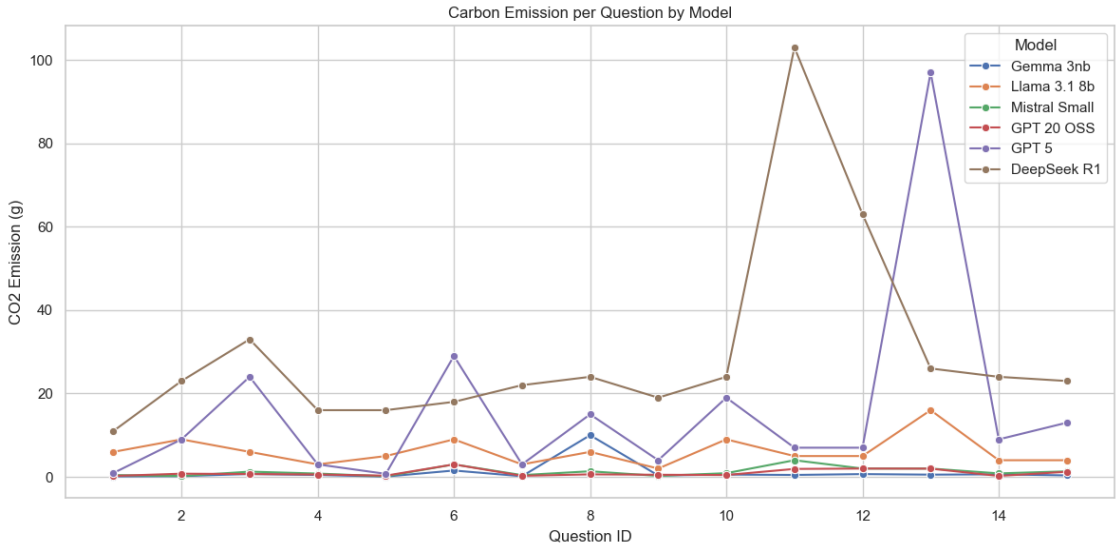
[14]:
```
import pandas as pd
import matplotlib.pyplot as plt
import numpy as np

# Aggregate KPI averages
kpi_avg = df.groupby('Model_Category')[['Rating', 'Electricity_Wh', 'CO2_g',␣
 ↪'Inference_s']].mean()

# Normalize for radar chart
kpi_norm = (kpi_avg - kpi_avg.min()) / (kpi_avg.max() - kpi_avg.min())

# Radar chart setup
labels = kpi_norm.columns.tolist()
num_vars = len(labels)
angles = np.linspace(0, 2 * np.pi, num_vars, endpoint=False).tolist()
angles += angles[:1]  # close the loop

plt.figure(figsize=(8, 8))
for idx, row in kpi_norm.iterrows():
    values = row.tolist()
    values += values[:1]
    plt.polar(angles, values, label=idx, linewidth=2)
    plt.fill(angles, values, alpha=0.1)
```

```
plt.xticks(angles[:-1], labels)
plt.title('KPI Profile per Model Category (Normalized)')
plt.legend(loc='upper right', bbox_to_anchor=(1.3, 1))
plt.tight_layout()
plt.show()
```



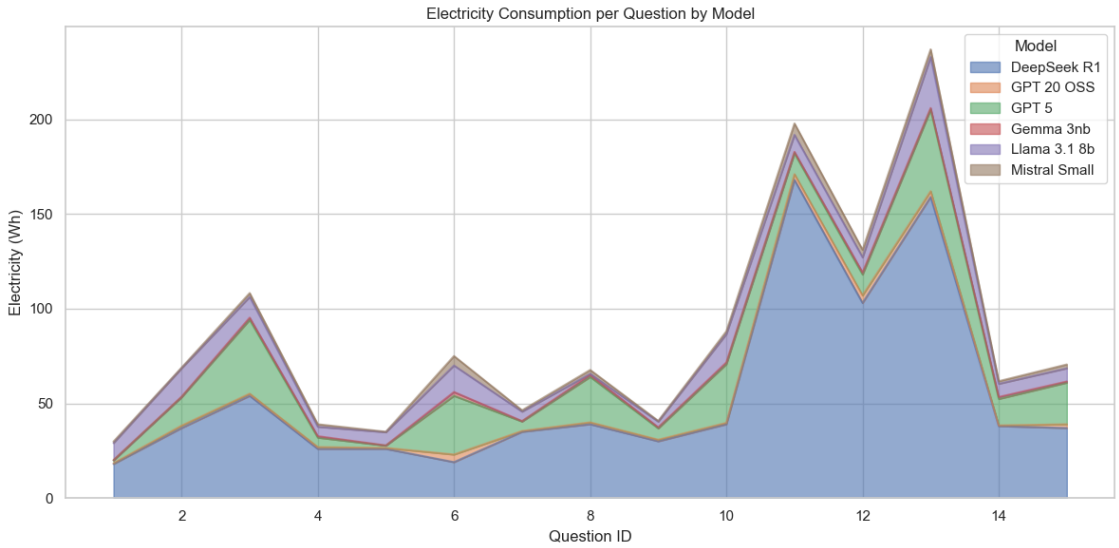
0.0.5 Chart 1: Carbon Emission per Question by Model (Line Chart)

[ ]:
```
plt.figure(figsize=(12, 6))
sns.lineplot(data=df, x='Question_ID', y='CO2_g', hue='Model', marker='o')
plt.title('Carbon Emission per Question by Model')
plt.xlabel('Question ID')
plt.ylabel('CO2 Emission (g)')
plt.tight_layout()
plt.show()
# category wise analysis
```



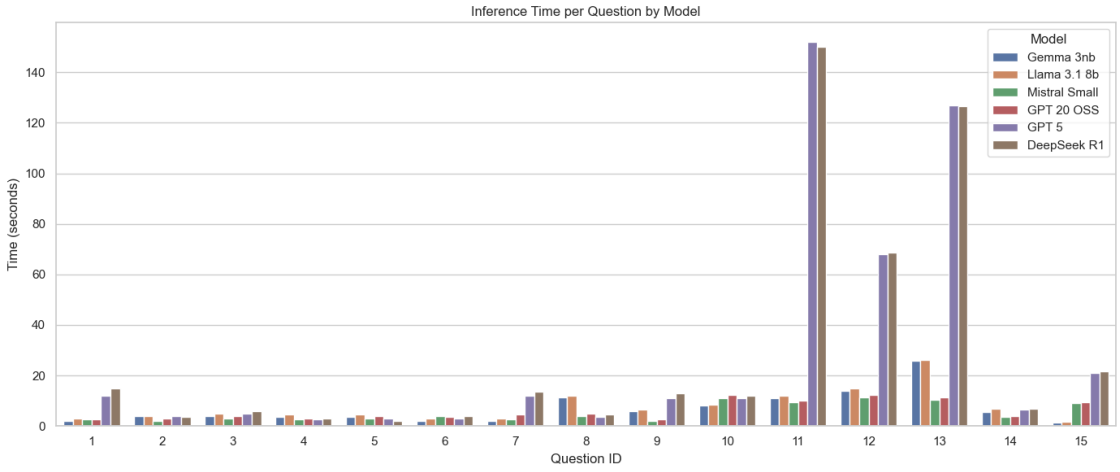
0.0.6 Chart 2: Electricity Consumption per Question by Model (Area Chart)

[19]:
```
pivot_ec = df.pivot_table(index='Question_ID', columns='Model',␣
↪values='Electricity_Wh')
pivot_ec.plot(kind='area', figsize=(12, 6), alpha=0.6)
plt.title('Electricity Consumption per Question by Model')
plt.xlabel('Question ID')
plt.ylabel('Electricity (Wh)')
plt.tight_layout()
plt.show()
```



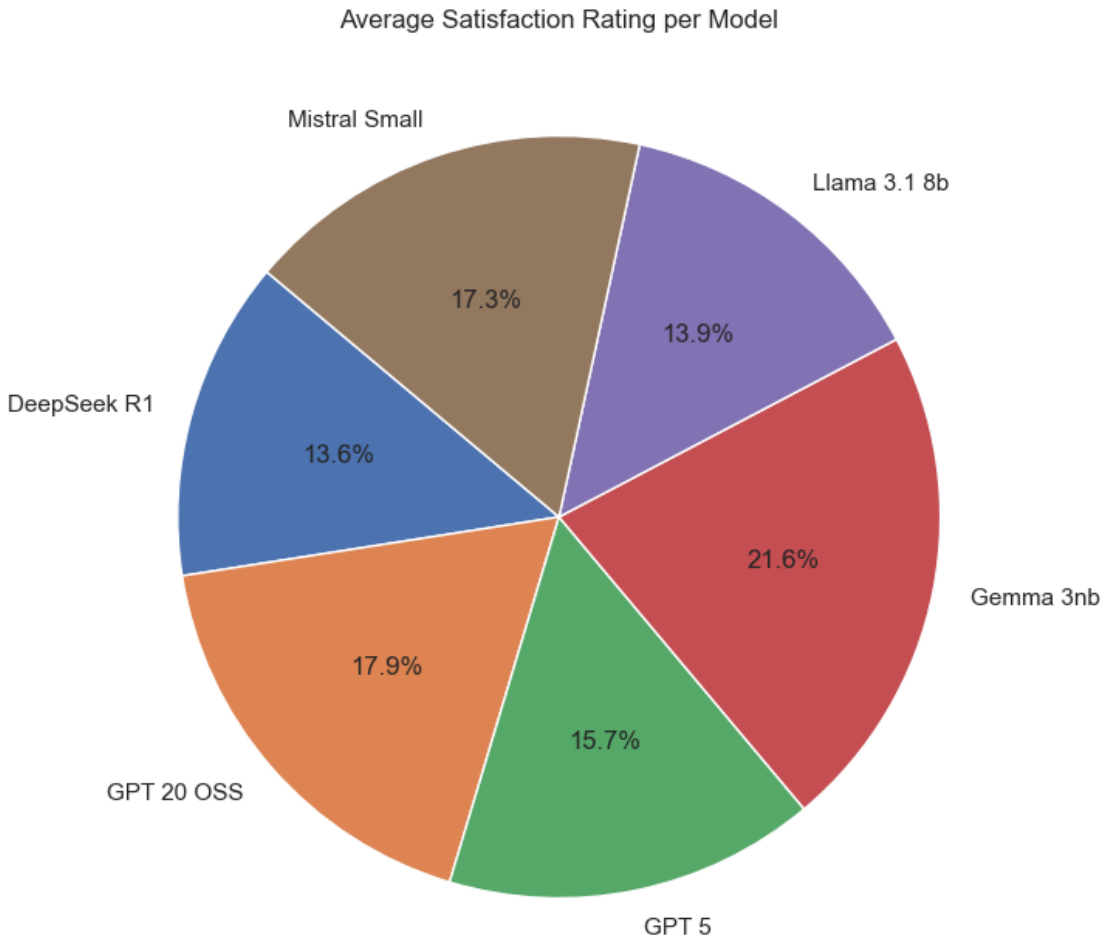
0.0.7 Chart 3: Inference Time(in Seconds) per Question by Model (Bar Chart)

[20]:
```
plt.figure(figsize=(14, 6))
sns.barplot(data=df, x='Question_ID', y='Inference_s', hue='Model')
plt.title('Inference Time per Question by Model')
plt.xlabel('Question ID')
plt.ylabel('Time (seconds)')
plt.tight_layout()
plt.show()
```



0.0.8 Chart 4: Average Rating Distribution (Pie Chart)

[23]:
```
avg_rating = df.groupby('Model')['Rating'].mean()
plt.figure(figsize=(8, 8))
plt.pie(avg_rating, labels=avg_rating.index, autopct='%1.1f%%', startangle=140)
plt.title('Average Satisfaction Rating per Model')
plt.show()
```



0.0.9 Chart 5: Total Carbon Emission by Models (Doughnut Chart)

[ ]:

[21]:
```
total_carbon = df.groupby('Model')['CO2_g'].sum()
fig, ax = plt.subplots(figsize=(8, 8))
wedges, texts, autotexts = ax.pie(total_carbon, labels=total_carbon.index,␣
↪autopct='%1.1f%%', startangle=90)
centre_circle = plt.Circle((0, 0), 0.70, fc='white')
fig.gca().add_artist(centre_circle)
plt.title('Total Carbon Emission by Model')
plt.tight_layout()
plt.show()
```

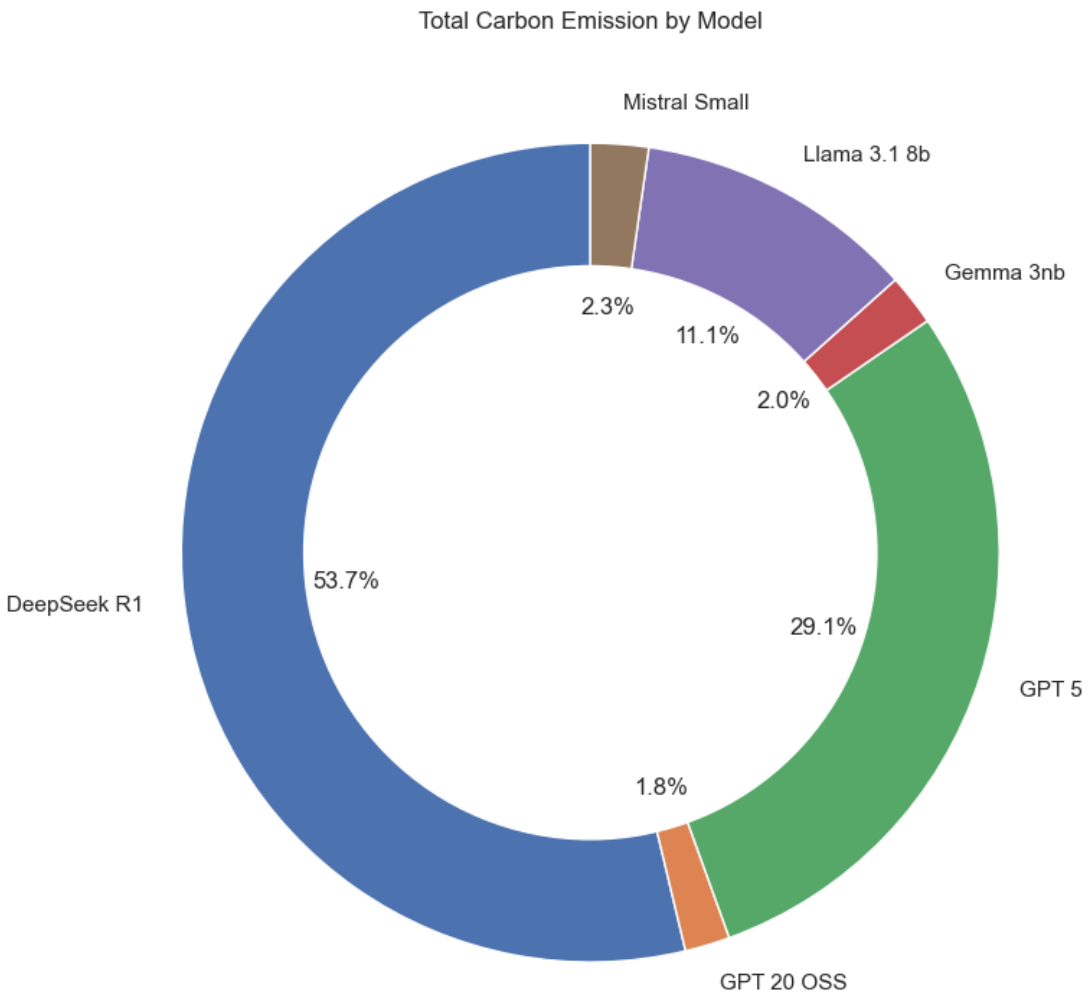


Chart 5: Total Carbon Emission by Model (Doughnut Chart) total_carbon = df.groupby('Model')['CO2_g'].sum() fig, ax = plt.subplots(figsize=(8, 8)) wedges, texts, autotexts = ax.pie(total_carbon, labels=total_carbon.index, autopct='%1.1f%%', startangle=90) centre_circle = plt.Circle((0, 0), 0.70, fc='white') fig.gca().add_artist(centre_circle) plt.title('Total Carbon Emission by Model') plt.tight_layout() plt.show()

Chart 6: Scatter Plot of Electricity vs Carbon Emission (Pyplot) plt.figure(figsize=(10, 6)) sns.scatterplot(data=df, x='Electricity_Wh', y='CO2_g', hue='Model', style='Is_Math', s=100) plt.title('Electricity vs Carbon Emission (Math vs Non-Math)') plt.xlabel('Electricity (Wh)') plt.ylabel('CO2 Emission (g)') plt.tight_layout() plt.show()

Bonus Ideas - Add tooltips using plotly.express for interactivity - Export charts as PNG/PDF for presentations - Use FacetGrid to compare math vs non-math questions We can create a downloadable .ipynb notebook or add a KPI summary table

0.0.10 1. Quality vs Energy (Scatter Plot)

[24]:
```
import plotly.express as px

fig = px.scatter(
    df,
    x='Electricity_Wh',
    y='Rating',
    color='Model',
    hover_data=['Question_ID', 'CO2_g', 'Inference_s'],
    title='Quality vs Energy Consumption'
)
fig.update_layout(width=900, height=500)
fig.show()
```

0.0.11 2. Quality vs Cost (Scatter Plot)

[25]:
```
fig = px.scatter(
    df,
    x='CO2_g',
    y='Rating',
    color='Model',
    hover_data=['Question_ID', 'Electricity_Wh', 'Inference_s'],
    title='Quality vs Carbon Emission (Cost Proxy)'
)
fig.update_layout(width=900, height=500)
fig.show()
```

0.0.12 3. Latency Comparison (Box Plot)

[26]:
```
fig = px.box(
    df,
    x='Model',
    y='Inference_s',
    color='Model',
    title='Latency Distribution per Model'
)
fig.update_layout(width=900, height=500)
fig.show()
```

0.0.13 4. Final "Best Trade-Off" Table

We'll define a simple scoring function

[27]:
```
df['Score'] = (
    df['Rating'] * 2
    - df['Electricity_Wh'] * 0.5
    - df['CO2_g'] * 0.5
```

```
    - df['Inference_s'] * 0.2
).round(2)

tradeoff_table = df.groupby('Model').agg({
    'Rating': 'mean',
    'Electricity_Wh': 'mean',
    'CO2_g': 'mean',
    'Inference_s': 'mean',
    'Score': 'mean'
}).round(2).sort_values(by='Score', ascending=False)

tradeoff_table.reset_index(inplace=True)
tradeoff_table
```

[27]:

	Model	Rating	Electricity_Wh	CO2_g	Inference_s	Score
0	Gemma 3nb	4.67	0.77	1.12	6.95	7.00
1	GPT 20 OSS	3.87	1.56	0.98	6.13	5.23
2	Mistral Small	3.73	2.10	1.26	5.39	4.71
3	Llama 3.1 8b	3.00	9.51	6.13	7.71	-3.36
4	GPT 5	3.40	17.31	16.04	29.43	-15.77
5	DeepSeek R1	2.93	55.20	29.67	30.00	-42.57

0.0.14 This above table ranks models by their overall efficiency and satisfaction balance.

[28]:
```
import streamlit as st

st.title("AI Model KPI Dashboard")

# st.plotly_chart(fig_quality_energy)
# st.plotly_chart(fig_quality_cost)
# st.plotly_chart(fig_latency)
st.dataframe(tradeoff_table)
```

```
2025-10-29 11:38:51.940
  Warning: to view this Streamlit app on a browser, run it with the
following
  command:

    streamlit run C:\Users\Gaurav Chugh\AppData\Roaming\Python\Python312\site-
packages\ipykernel_launcher.py [ARGUMENTS]
```

[28]:
```
DeltaGenerator()
```