iadapt_geoforum

July 6, 2023

1 Introduction

This notebook contains the data analysis of pre- and post survey results relating to phase I of the iAdapt project. The latest version is always available here, on Github and as a deposit on Zenodo.

In step 1, Likert data from the results are first converted to ordinal values, then analysed using the Mann-Whitney U test. Statistically significant question results have a Cohen's d effect assigned.

In step 2, pre- and post question data are graphed in small multiples according to their capability grouping, for further discussion.

Note: `Start time` and `ID` are not used in this analysis but are retained for data quality and assurance reasons, allowing them to be matched with the retained read-only survey response data if necessary.

[1]:
```
import pandas as pd
import matplotlib.pyplot as plt
from matplotlib.ticker import PercentFormatter
import numpy as np

from statsmodels.stats.nonparametric import rank_compare_2indep
from statsmodels.stats.weightstats import ttest_ind
from statsmodels.stats.power import TTestIndPower
```

[2]:
```
%matplotlib inline
%config InlineBackend.figure_format='retina'

plt.rcParams.update({
    "text.usetex": True,
    "font.family": "sans-serif",
    "font.sans-serif": "Helvetica",
})
```

[49]:
```
ecc ='#000000'
ecw=0.25

histcolors = ["#008080", "#980043"]
```

2 Step 1: convert Likert data to ordinal values

[ ]:
```
qs = ["Q1", "Q2", "Q3", "Q4", "Q5", "Q6", "Q7", "Q8", "Q9", "Q10", "Q11", "Q12"]

# rename questions for ease of handling
questions_sub = {
    "I think about climate change": "Q1",
    "I think the world's climate is changing": "Q2",
    "I'm worried about the effects of climate change on my community": "Q3",
    "I think it's too late to do anything about climate change": "Q4",
    "I know about the history of flooding in my community": "Q5",
    "I know what the government and local authority are doing to help my␣
 ↪community to cope with climate change": "Q6",
    "I understand the difference between climate change mitigation and climate␣
 ↪change adaptation": "Q7",
    "I think technology is the most important tool we have to help us to adapt␣
 ↪to climate change": "Q8",
    "I think interactive maps are a useful tool for talking about and␣
 ↪demonstrating the effects of climate change": "Q9",
    "Games are a good way to help us to imagine the effects of climate change":␣
 ↪"Q10",
    "Imagining what our lives will be like in the future is a good way to␣
 ↪discuss adaptation to climate change": "Q11",
    "I think that changing my own behaviour can help to limit the effects of␣
 ↪climate change": "Q12"
}

# allow original question text to be looked up using Q[n]
flipped = dict((v, k) for k, v in questions_sub.items())

# Assign ordinal values to Likert questions
values_sub = {
    "Never": 1,
    "Rarely": 2,
    "Sometimes": 3,
    "Often": 4,
    "Very often": 5,
    "All the time": 6,
    "Definitely not changing": 1,
    "Probably not changing": 2,
    "Maybe changing": 3,
    "Probably changing": 4,
    "Definitely changing": 5,
    "Climate change isn't happening": 1,
    "Not worried at all": 2,
    "Neutral": 3,
    "A little worried": 4,
```

```
    "Very worried": 5,
    "Extremely worried": 6,
    "Strongly disagree": 1,
    "Disagree": 2,
    "Neutral": 3,
    "Agree": 4,
    "Strongly agree": 5,
}
```

[47]:
```
df = pd.read_csv("survey_results.csv")
df.rename(columns=questions_sub, inplace=True)
df.replace(values_sub, inplace=True)
df.drop(columns=df.columns[0], axis=1, inplace=True)
df.head()
```

[47]:

	ID	prepost	Start time	Q1	Q2	Q3	Q4	Q5	Q6	Q7	Q8	Q9	Q10	Q11	Q12	deis
0	132	pre	2022-09-13 13:59:10	2	4	2	3	2	1	1	4	3	4	4	3	True
1	127	pre	2022-09-13 13:59:26	1	2	1	3	1	1	1	3	3	4	3	1	True
2	128	pre	2022-09-13 13:59:26	2	5	4	2	4	1	3	5	3	4	4	5	True
3	131	pre	2022-09-13 13:59:26	2	5	4	2	3	3	4	4	4	4	4	4	True
4	129	pre	2022-09-13 13:59:27	3	5	3	3	1	2	2	3	3	4	4	3	True

[42]:
```
len(df.query("prepost == 'pre'")), len(df.query("prepost == 'post'"))
```

[42]: (374, 239)

3 Helper Functions

3.1 Used for interpreting the Mann-Whitney U test results

[45]:
```
def significant(pvalue):
    """
    Indicate significance at p < 0.05
    """
    if pvalue < 0.05:
        return f"{pvalue} *"
    else:
        return f"{pvalue}"
```

```
def size_cat(stat, q, effect):
    """
    Return Cohen's d / Hedge's g effect size category
    Size refers to standard deviations (the z statistic)
    """
    # sign isn't important when determining these since it depends on input␣
 ↪order
    # (of MWU stat in this case)
    if effect < 0:
        mean = "(Decreased Mean)"
    else:
        mean = ""
    effect = abs(effect)
    common = f"{stat} {q}: {effect}"
    if 0 <= effect < 0.18:
        s = common
    if 0.18 <= effect < 0.20:
        s = f"{common} <== Marginal Effect {mean}"
    elif 0.20 <= effect < 0.50:
        s = f"{common} <== Small Effect {mean}"
    elif 0.50 <= effect < 0.80:
        s = f"{common} <== Medium Effect {mean}"
    elif effect >= 0.80:
        s = f"{common} <== Large Effect {mean}"
    else:
        s = common
        # raise Exception("Effect less than 0!")
    return s

q_post = "prepost == 'post'"
q_pre = "prepost == 'pre'"


mwu_res = {q: rank_compare_2indep(
            df.query(q_post)[q],
            df.query(q_pre)[q],
            use_t=True) for q in qs
          }

# not currently used in analysis, but useful nevertheless
ttest_res = {q: ttest_ind(
            df.query(q_post)[q],
            df.query(q_pre)[q],
            ) for q in qs
          }
```

4 Mann-Whitney U-Test Results, using `statsmodels`

4.1 Statistically significant `p` values are indicated with a `*`

4.1.1 Note: the `p` value assumes a `t` distribution

[32]:
```
print("Significance of M-W U test stat\n")
for k, v in mwu_res.items():
    effectsize = mwu_res[k].effectsize_normal()
    # print(f"{k} ({v.statistic}): {significant(v.pvalue)}")
    print(size_cat(f"{k}: Cohen's d", f"(p: {significant(v.pvalue)})",␣
 ↪effectsize))
```

```
Significance of M-W U test stat

Q1: Cohen's d (p: 0.2527828860831631): 0.09318536212575455
Q2: Cohen's d (p: 0.39399586148363575): 0.061370835425927125
Q3: Cohen's d (p: 0.9833792196400033): 0.0016656541057724116
Q4: Cohen's d (p: 0.016919232311135672 *): 0.18909811221455167 <== Marginal
Effect (Decreased Mean)
Q5: Cohen's d (p: 0.809699801637204): 0.019829860738294753
Q6: Cohen's d (p: 0.08908499931813138): 0.1375736189310758
Q7: Cohen's d (p: 3.8564332329533394e-10 *): 0.5047582634745633 <== Medium
Effect
Q8: Cohen's d (p: 0.1260941753281461): 0.12476843039805037
Q9: Cohen's d (p: 0.14668020428599282): 0.11712610679497289
Q10: Cohen's d (p: 0.0018117625460926088 *): 0.24955077144649002 <== Small
Effect
Q11: Cohen's d (p: 0.5829778433178705): 0.04450409375804361
Q12: Cohen's d (p: 0.6818852558122269): 0.03347483373095854
```

5 Small Multiple graphs of questions

5.1 Knowledge and Learning

5.1.1 Q1, Q2, Q7, Q8

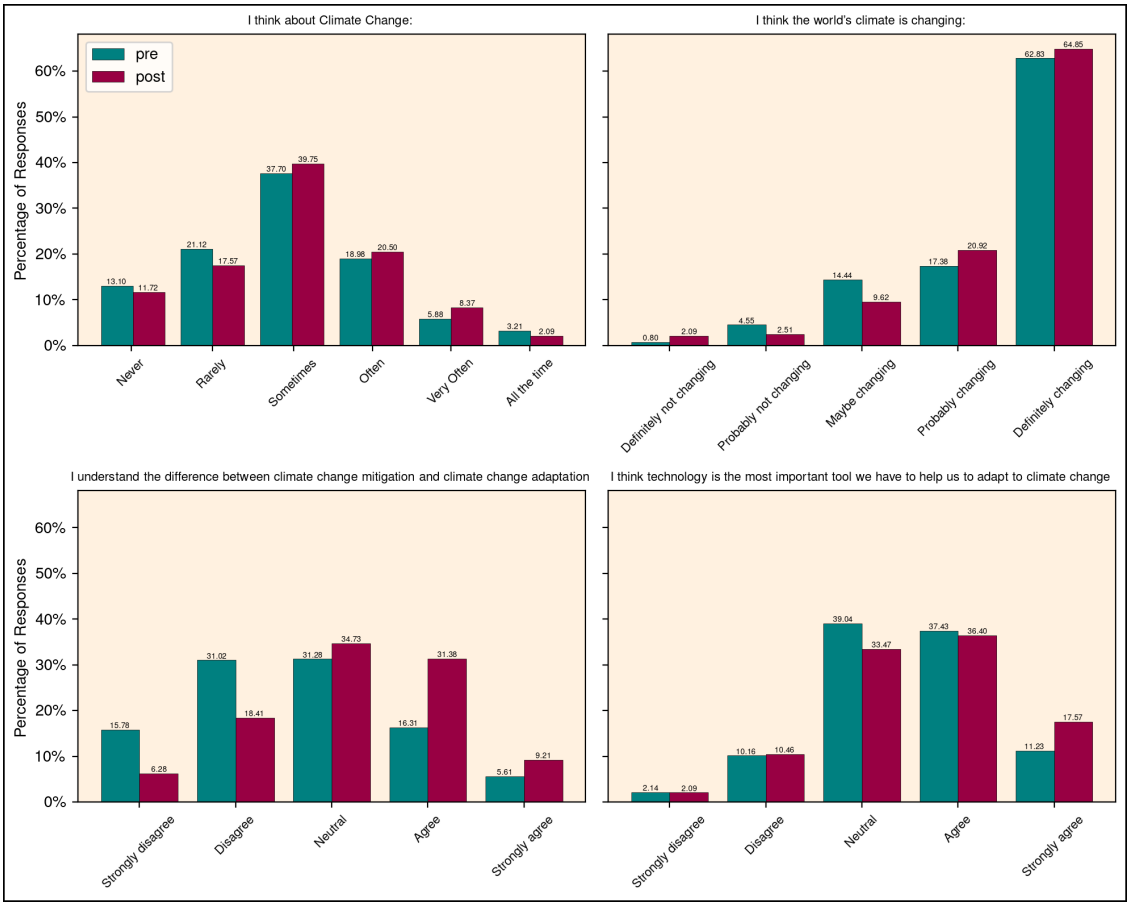
[36]:
```
tsize=8
ssize=5

plt.clf()
fig, axes = plt.subplots(
    nrows=2,
    ncols=2,
    sharey=True,
    facecolor="#ffffff",
    edgecolor="#000000",
    linewidth=2,
    figsize=(10, 8)
```

```
)

ax1 = axes[0, 0]
ax2 = axes[0, 1]
ax3 = axes[1, 0]
ax4 = axes[1, 1]

ax1.set_ylabel('Percentage of Responses')


# Q1
pre = df[df['prepost'] == 'pre']['Q1']
post = df[df['prepost'] == 'post']['Q1']


# n contains percentages
(n, bins, patches) = ax1.hist([
    df[df['prepost'] == 'pre']['Q1'],
    df[df['prepost'] == 'post']['Q1']
],
    weights = [
        [100 / len(pre)] * len(pre),
        [100 / len(post)] * len(post),
    ],
    ec=ecc, lw=ecw, color=histcolors,
    bins=6, label=['pre', 'post']
)
ax1.set_facecolor("#FFF1E0")
ax1.set_xticks((1.4, 2.25, 3.1, 3.925, 4.75, 5.575))
ax3.yaxis.set_major_formatter(PercentFormatter(100, decimals=0))
ax1.set_xticklabels(["Never", "Rarely", "Sometimes", "Often", "Very Often",␣
 ↪"All the time"], rotation=45, size=tsize)
ax1.set_ylabel('Percentage of Responses')
ax1.legend(loc='upper left')
ax1.set_title("I think about Climate Change:", size=tsize)

for b in patches:
    ax1.bar_label(b, size=ssize, fmt="%.2f %%")


# Q2
ax2 = axes[0, 1]
pre = df[df['prepost'] == 'pre']['Q2']
post = df[df['prepost'] == 'post']['Q2']

# n contains percentages
(n, bins, patches) = ax2.hist([
```

```
    df[df['prepost'] == 'pre']['Q2'],
    df[df['prepost'] == 'post']['Q2']
],
    weights = [
        [100 / len(pre)] * len(pre),
        [100 / len(post)] * len(post),
    ],
    ec=ecc, lw=ecw, color=histcolors,
    bins=5, label=['pre', 'post']
)

ax2.set_facecolor("#FFF1E0")
ax2.set_xticks((1.4, 2.2, 3, 3.8, 4.6))
ax3.yaxis.set_major_formatter(PercentFormatter(100, decimals=0))
ax2.set_xticklabels([
    "Definitely not changing",
    "Probably not changing",
    "Maybe changing",
    "Probably changing",
    "Definitely changing"], rotation=45, size=tsize)

ax2.set_title("I think the world's climate is changing:", size=tsize)

for b in patches:
    ax2.bar_label(b, size=ssize, fmt="%.2f %%")

# Q7

pre = df[df['prepost'] == 'pre']['Q7']
post = df[df['prepost'] == 'post']['Q7']


# n contains percentages
(n, bins, patches) = ax3.hist([
    df[df['prepost'] == 'pre']['Q7'],
    df[df['prepost'] == 'post']['Q7']
],
    weights = [
        [100 / len(pre)] * len(pre),
        [100 / len(post)] * len(post),
    ],
    ec=ecc, lw=ecw, color=histcolors,
    bins=5, label=['pre', 'post']
)
ax3.set_facecolor("#FFF1E0")
ax3.set_xticks((1.4, 2.2, 3, 3.8, 4.6))
ax3.yaxis.set_major_formatter(PercentFormatter(100, decimals=0))
```

```
ax3.set_xticklabels(["Strongly disagree", "Disagree", "Neutral", "Agree",␣
 ↪"Strongly agree"], rotation=45, size=tsize)
ax3.set_ylabel('Percentage of Responses')

ax3.set_title(f"{flipped['Q7']}", size=tsize)
for b in patches:
    ax3.bar_label(b, size=ssize, fmt="%.2f %%")

# Q8

pre = df[df['prepost'] == 'pre']['Q8']
post = df[df['prepost'] == 'post']['Q8']


# n contains percentages
(n, bins, patches) = ax4.hist([
    df[df['prepost'] == 'pre']['Q8'],
    df[df['prepost'] == 'post']['Q8']
],
    weights = [
        [100 / len(pre)] * len(pre),
        [100 / len(post)] * len(post),
    ],
    ec=ecc, lw=ecw, color=histcolors,
    bins=5, label=['pre', 'post']
)
ax4.set_facecolor("#FFF1E0")
ax4.set_xticks((1.4, 2.2, 3, 3.8, 4.6))
ax3.yaxis.set_major_formatter(PercentFormatter(100, decimals=0))
ax4.set_xticklabels(["Strongly disagree", "Disagree", "Neutral", "Agree",␣
 ↪"Strongly agree"], rotation=45, size=tsize)

ax4.set_title(f"{flipped['Q8']}", size=tsize)
for b in patches:
    ax4.bar_label(b, size=ssize, fmt="%.2f %%")

plt.tight_layout()
plt.savefig("knowledge_learning.png", edgecolor=fig.get_edgecolor(), dpi=300)
plt.show()
```

```
<Figure size 640x480 with 0 Axes>
```



5.2 Agency and Empowerment

5.2.1 Q3, Q4, Q12

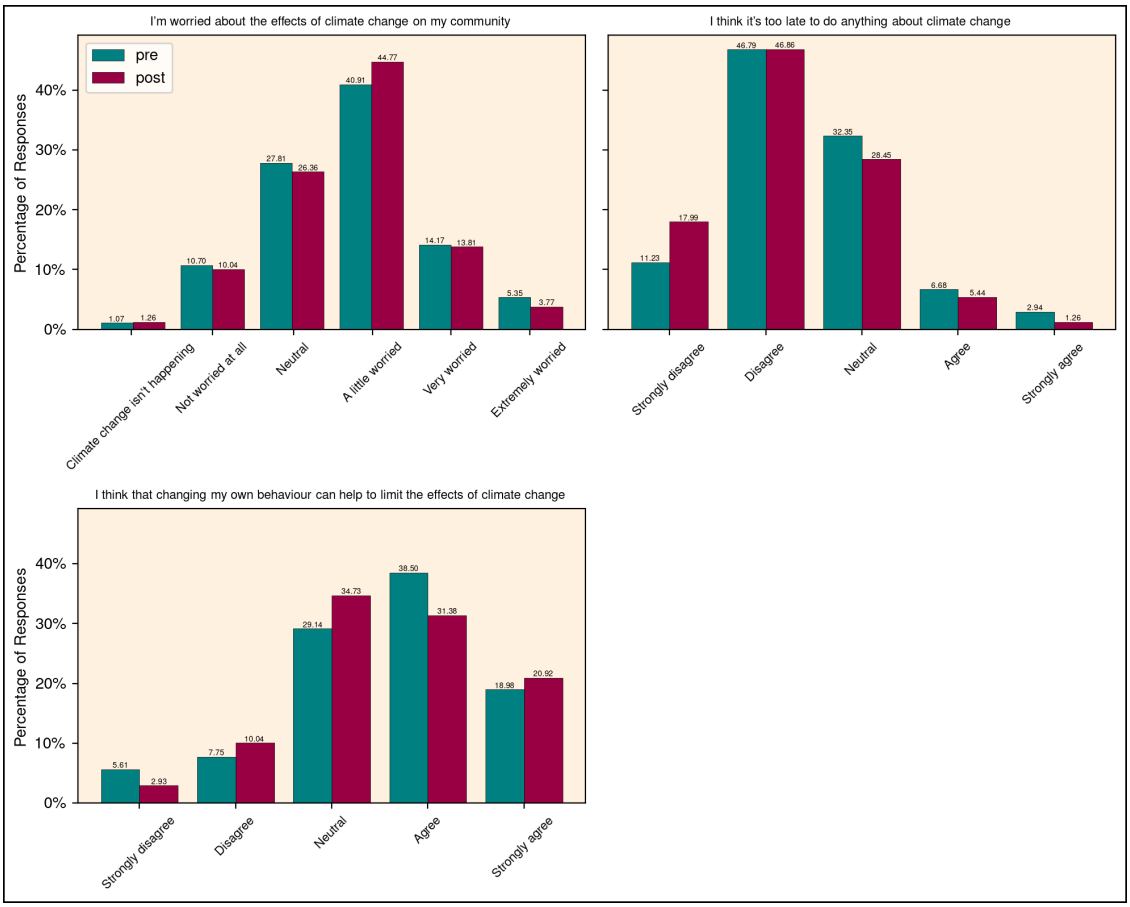
[38]:
```
plt.clf()
fig, axes = plt.subplots(
    nrows=2,
    ncols=2,
    sharey=True,
    facecolor="#ffffff",
    edgecolor="#000000",
    linewidth=2,
    figsize=(10, 8)
)

ax1 = axes[0, 0]
ax2 = axes[0, 1]
ax3 = axes[1, 0]
ax4 = axes[1, 1]
```

```
ax1.set_ylabel('Percentage of Responses')


# Q3
pre = df[df['prepost'] == 'pre']['Q3']
post = df[df['prepost'] == 'post']['Q3']


# n contains percentages
(n, bins, patches) = ax1.hist([
    df[df['prepost'] == 'pre']['Q3'],
    df[df['prepost'] == 'post']['Q3']
],
    weights = [
        [100 / len(pre)] * len(pre),
        [100 / len(post)] * len(post),
    ],
    ec=ecc, lw=ecw, color=histcolors,
    bins=6, label=['pre', 'post']
)

ax1.set_xticks((1.4, 2.25, 3.1, 3.925, 4.75, 5.575))
ax3.yaxis.set_major_formatter(PercentFormatter(100, decimals=0))
ax1.set_xticklabels(["Climate change isn't happening", "Not worried at all",␣
 ↪"Neutral", "A little worried", "Very worried", "Extremely worried"],␣
 ↪rotation=45, size=tsize)

ax1.set_facecolor("#FFF1E0")
ax1.set_ylabel('Percentage of Responses')
ax1.legend(loc='upper left')
ax1.set_title("I'm worried about the effects of climate change on my␣
 ↪community", size=tsize)

for b in patches:
    ax1.bar_label(b, size=ssize, fmt="%.2f %%")

# Q4
pre = df[df['prepost'] == 'pre']['Q4']
post = df[df['prepost'] == 'post']['Q4']


# n contains percentages
(n, bins, patches) = ax2.hist([
    df[df['prepost'] == 'pre']['Q4'],
    df[df['prepost'] == 'post']['Q4']
],
```

```
    weights = [
        [100 / len(pre)] * len(pre),
        [100 / len(post)] * len(post),
    ],
    ec=ecc, lw=ecw, color=histcolors,
    bins=5, label=['pre', 'post']
)
ax2.set_facecolor("#FFF1E0")
ax2.set_xticks((1.4, 2.2, 3, 3.8, 4.6))
ax3.yaxis.set_major_formatter(PercentFormatter(100, decimals=0))
ax2.set_xticklabels(["Strongly disagree", "Disagree", "Neutral", "Agree",␣
 ↪"Strongly agree"], rotation=45, size=tsize)

ax2.set_title(f"{flipped['Q4']}", size=tsize)
for b in patches:
    ax2.bar_label(b, size=ssize, fmt="%.2f %%")


# Q12
pre = df[df['prepost'] == 'pre']['Q12']
post = df[df['prepost'] == 'post']['Q12']


# n contains percentages
(n, bins, patches) = ax3.hist([
    df[df['prepost'] == 'pre']['Q12'],
    df[df['prepost'] == 'post']['Q12']
],
    weights = [
        [100 / len(pre)] * len(pre),
        [100 / len(post)] * len(post),
    ],
    ec=ecc, lw=ecw, color=histcolors,
    bins=5, label=['pre', 'post']
)
ax3.set_facecolor("#FFF1E0")
ax3.set_xticks((1.4, 2.2, 3, 3.8, 4.6))
ax3.yaxis.set_major_formatter(PercentFormatter(100, decimals=0))
ax3.set_xticklabels(["Strongly disagree", "Disagree", "Neutral", "Agree",␣
 ↪"Strongly agree"], rotation=45, size=tsize)
ax3.set_ylabel('Percentage of Responses')

ax3.set_title(f"{flipped['Q12']}", size=tsize)
for b in patches:
    ax3.bar_label(b, size=ssize, fmt="%.2f %%")

ax4.get_xaxis().set_visible(False)
```

```
ax4.get_yaxis().set_visible(False)
ax4.axis('off')

plt.tight_layout()
plt.savefig("agency_empowerment.png", edgecolor=fig.get_edgecolor(), dpi=300)
plt.show()
```

```
<Figure size 640x480 with 0 Axes>
```



5.3 Social Networks and Support

5.3.1 Q6, Q10, Q11

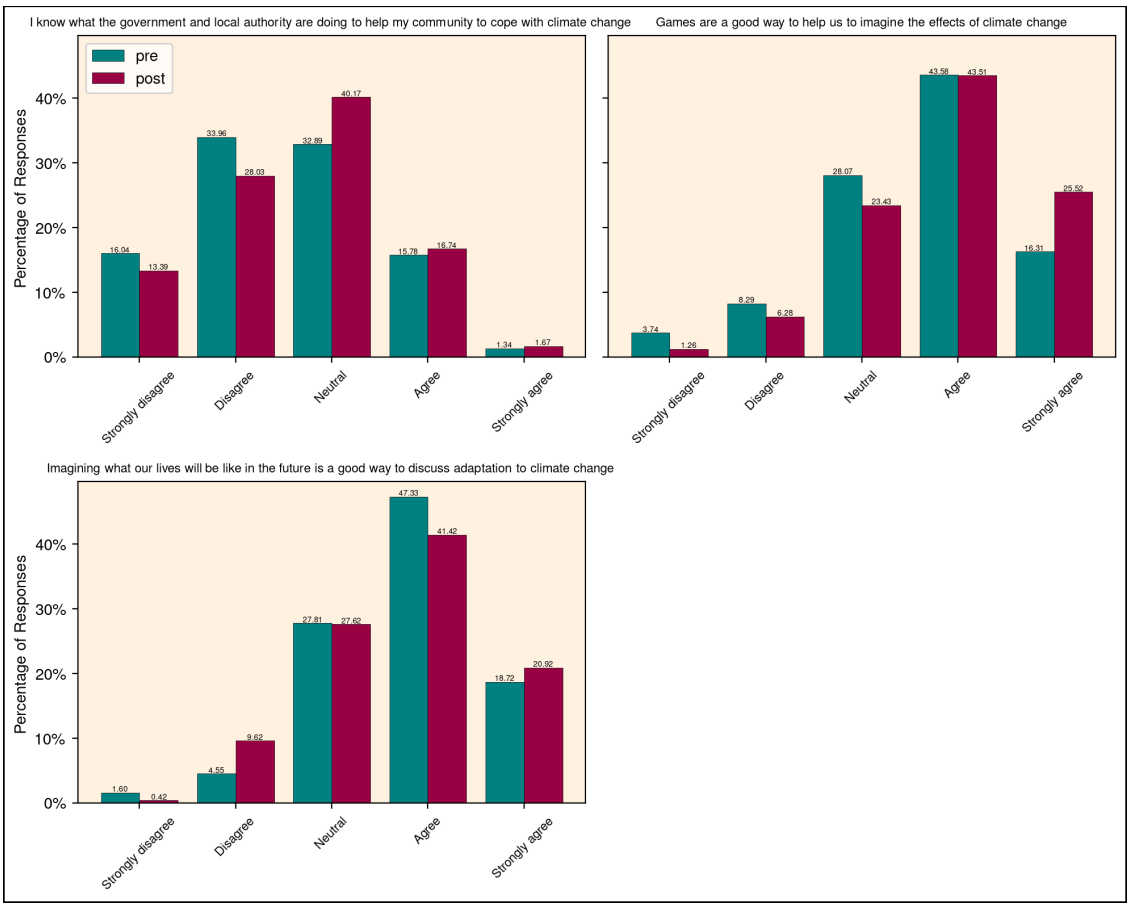
[39]:
```
plt.clf()
fig, axes = plt.subplots(
    nrows=2,
    ncols=2,
    sharey=True,
    facecolor="#ffffff",
    edgecolor="#000000",
```

```
    linewidth=2,
    figsize=(10, 8)
)

ax1 = axes[0, 0]
ax2 = axes[0, 1]
ax3 = axes[1, 0]
ax4 = axes[1, 1]

ax1.set_ylabel('Percentage of Responses')
ax1.set_facecolor("#FFF1E0")


# Q6
pre = df[df['prepost'] == 'pre']['Q6']
post = df[df['prepost'] == 'post']['Q6']


# n contains percentages
(n, bins, patches) = ax1.hist([
    df[df['prepost'] == 'pre']['Q6'],
    df[df['prepost'] == 'post']['Q6']
],
    weights = [
        [100 / len(pre)] * len(pre),
        [100 / len(post)] * len(post),
    ],
    ec=ecc, lw=ecw, color=histcolors,
    bins=5, label=['pre', 'post']
)

ax1.set_xticks((1.4, 2.2, 3, 3.8, 4.6))
ax1.yaxis.set_major_formatter(PercentFormatter(100, decimals=0))
ax1.set_xticklabels(["Strongly disagree", "Disagree", "Neutral", "Agree",␣
 ↪"Strongly agree"], rotation=45, size=tsize)

ax1.set_ylabel('Percentage of Responses')
ax1.legend(loc='upper left')
ax1.set_title(f"{flipped['Q6']}", size=tsize)

for b in patches:
    ax1.bar_label(b, size=ssize, fmt="%.2f %%")

# Q10
pre = df[df['prepost'] == 'pre']['Q10']
post = df[df['prepost'] == 'post']['Q10']
```

```
# n contains percentages
(n, bins, patches) = ax2.hist([
    df[df['prepost'] == 'pre']['Q10'],
    df[df['prepost'] == 'post']['Q10']
],
    weights = [
        [100 / len(pre)] * len(pre),
        [100 / len(post)] * len(post),
    ],
    ec=ecc, lw=ecw, color=histcolors,
    bins=5, label=['pre', 'post']
)
ax2.set_facecolor("#FFF1E0")
ax2.set_xticks((1.4, 2.2, 3, 3.8, 4.6))
ax2.yaxis.set_major_formatter(PercentFormatter(100, decimals=0))
ax2.set_xticklabels(["Strongly disagree", "Disagree", "Neutral", "Agree",␣
 ↪"Strongly agree"], rotation=45, size=tsize)

ax2.set_title(f"{flipped['Q10']}", size=tsize)
for b in patches:
    ax2.bar_label(b, size=ssize, fmt="%.2f %%")


# Q11
pre = df[df['prepost'] == 'pre']['Q11']
post = df[df['prepost'] == 'post']['Q11']


# n contains percentages
(n, bins, patches) = ax3.hist([
    df[df['prepost'] == 'pre']['Q11'],
    df[df['prepost'] == 'post']['Q11']
],
    weights = [
        [100 / len(pre)] * len(pre),
        [100 / len(post)] * len(post),
    ],
    ec=ecc, lw=ecw, color=histcolors,
    bins=5, label=['pre', 'post']
)
ax3.set_facecolor("#FFF1E0")
ax3.set_xticks((1.4, 2.2, 3, 3.8, 4.6))
ax3.yaxis.set_major_formatter(PercentFormatter(100, decimals=0))
ax3.set_xticklabels(["Strongly disagree", "Disagree", "Neutral", "Agree",␣
 ↪"Strongly agree"], rotation=45, size=tsize)
ax3.set_ylabel('Percentage of Responses')
```

```
ax3.set_title(f"{flipped['Q11']}", size=tsize)
for b in patches:
    ax3.bar_label(b, size=ssize, fmt="%.2f %%")

ax4.get_xaxis().set_visible(False)
ax4.get_yaxis().set_visible(False)
ax4.axis('off')

plt.tight_layout()
plt.savefig("social_networks_support.png", edgecolor=fig.get_edgecolor(),␣
 ↪dpi=300)
plt.show()
```

```
<Figure size 640x480 with 0 Axes>
```



[ ]: