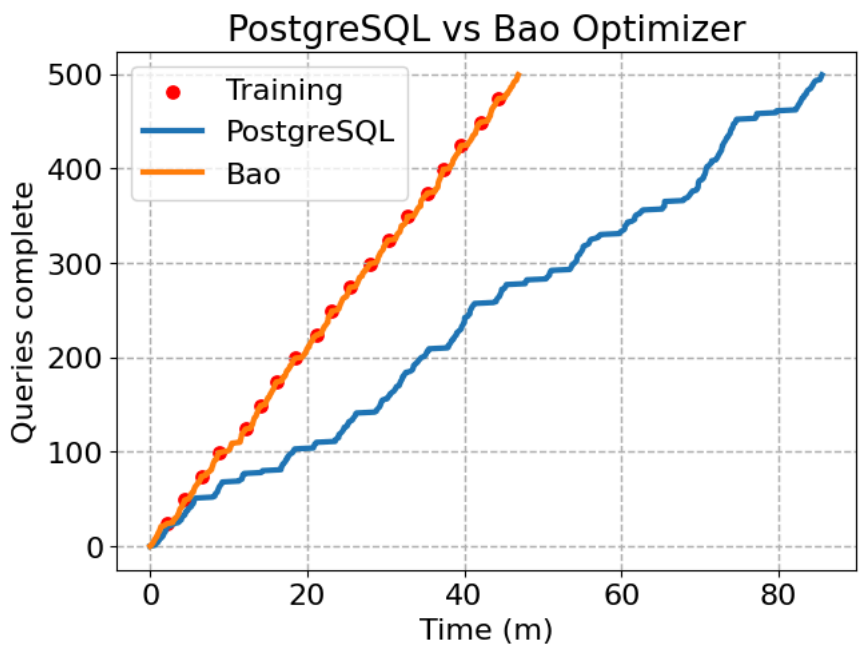
```
%matplotlib inline
import pandas as pd
import numpy as np
import matplotlib
from matplotlib import pyplot as plt
import string
from collections import defaultdict
```

```
plt.rcParams["font.size"] = 16
SHOW_RG = False
src_fp = f'/Users/saharshbarve/Work/uiuc/study/Semester_3/cs511/project-bao/breakingBao/exp3-schema-drop-idx/40perct_drop_inde
bao_run_path = f'{src_fp}/bao_run.txt'
pg_run_path = f'{src_fp}/pg_run.txt'
```

```
with open(pg_run_path) as f:
    data = f.read().split("\n")[2:]
data = [x.split(" ") for x in data if len(x) > 1 and (x[0] in string.digits or x[0] == "x")]

data = [(x[0], x[1], float(x[2]), x[3], float(x[4])) for x in data]
pg_data = data
pg_times = np.array([x[2] for x in pg_data])
pg_times -= np.min(pg_times)
pg_times /= 60


def read_bao_data(fp):
    with open(fp) as f:
        data = f.read().split("\n")[2:]

    training_times = []
    for idx in range(len(data)):
        if data[idx].strip().startswith("Initial input channels"):
            prev_line = data[idx-1].split(" ")
            if prev_line[0] == "Retry":
                continue
            training_times.append(float(prev_line[2]))


    training_times = np.array(training_times)

    data = [x.split(" ") for x in data if len(x) > 1 and (x[0] in string.digits or x[0] == "x")]
    data = [(x[0], x[1], float(x[2]), x[3], float(x[4])) for x in data]
    bao_data = data

    bao_times = np.array([x[2] for x in bao_data])
    training_times -= np.min(bao_times)
    bao_times -= np.min(bao_times)

    bao_times /= 60
    training_times /= 60
    return bao_data, bao_times, training_times

bao_data, bao_times, training_times = read_bao_data(bao_run_path)
if SHOW_RG:
    bao_rb_data, bao_rb_times, training_rb_times = read_bao_data("bao_with_regblock.txt")
```

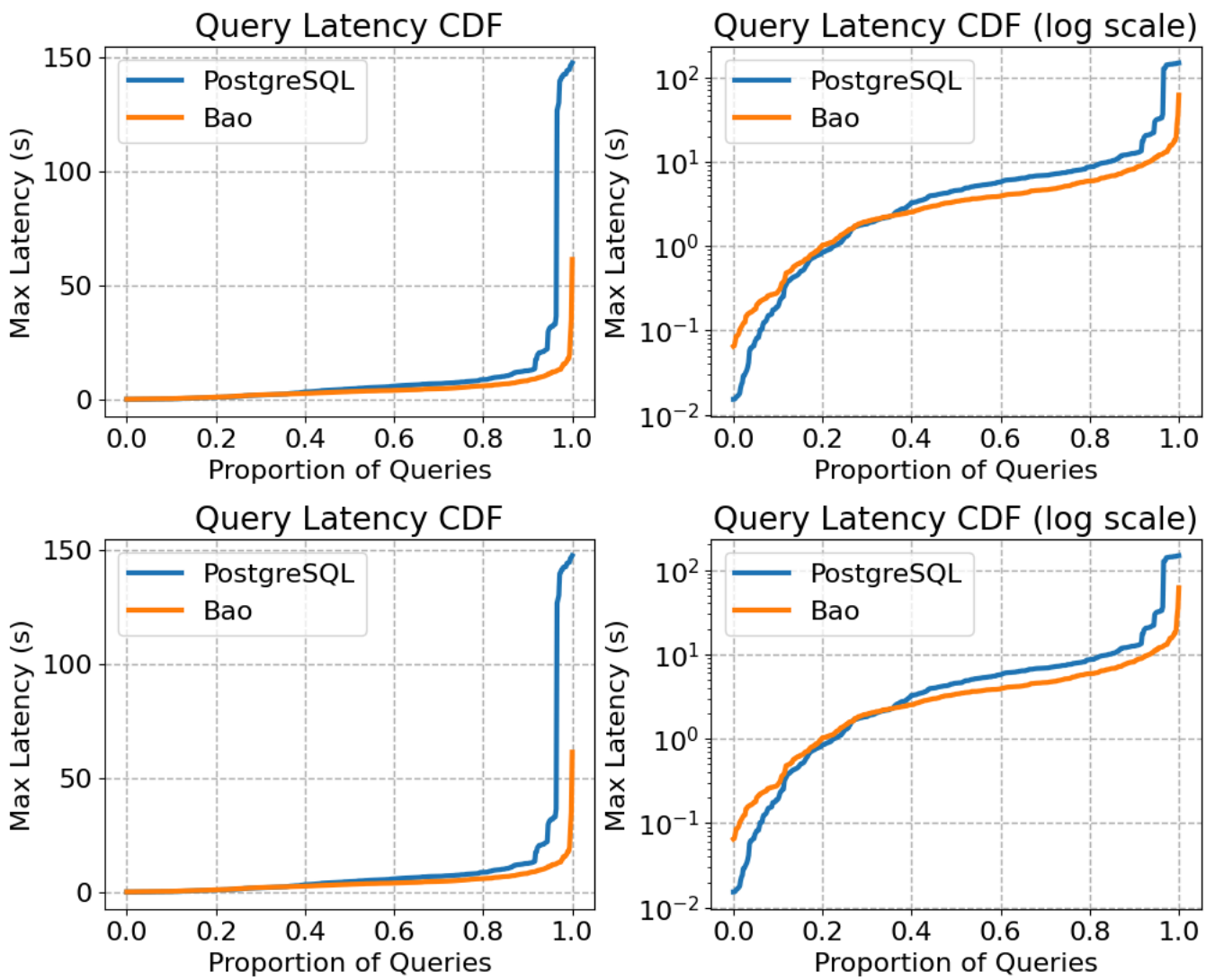
```
queries_complete = np.arange(0, len(pg_times))

fig, ax = plt.subplots(1, 1, constrained_layout=True)


train_y = []
train_rb_y = []
for tt in training_times:
    idx = np.searchsorted(bao_times, tt)
    train_y.append(idx)

if SHOW_RG:
    for tt in training_rb_times:
        idx = np.searchsorted(bao_rb_times, tt)
        train_rb_y.append(idx)

plt.scatter(training_times, train_y, s=45, color="red", label="Training")

```

```
ax.plot(pg_times, queries_complete, label="PostgreSQL", lw=3)
ax.plot(bao_times, queries_complete, label="Bao", lw=3)

if SHOW_RG:
    plt.scatter(training_rb_times, train_rb_y, s=45, color="red")
    ax.plot(bao_rb_times, queries_complete, label="Bao (w/ exploration)", lw=3)

ax.set_xlabel("Time (m)")
ax.set_ylabel("Queries complete")
ax.set_title("PostgreSQL vs Bao Optimizer")

ax.grid(linestyle="--", linewidth=1)
ax.legend()
fig.savefig("queries_vs_time.svg")
```




```
all_pg_times = sorted([x[4] for x in pg_data])
all_bao_times = sorted([x[4] for x in bao_data])

if SHOW_RG:
    all_bao_rb_times = sorted([x[4] for x in bao_rb_data])


fig, axes = plt.subplots(1, 2, figsize=(10, 4), constrained_layout=True)

ax = axes[0]
ax.plot(np.linspace(0, 1, len(all_pg_times)), all_pg_times, lw=3, label="PostgreSQL")
ax.plot(np.linspace(0, 1, len(all_pg_times)), all_bao_times, lw=3, label="Bao")

if SHOW_RG:
    ax.plot(np.linspace(0, 1, len(all_pg_times)), all_bao_rb_times, lw=3, label="Bao (w/ exploration)")

ax.grid(linestyle="--", linewidth=1)
ax.set_xlabel("Proportion of Queries")
ax.set_ylabel("Max Latency (s)")
ax.set_title("Query Latency CDF")
ax.legend()
#ax.set_yscale("log")


ax = axes[1]
ax.plot(np.linspace(0, 1, len(all_pg_times)), all_pg_times, lw=3, label="PostgreSQL")
ax.plot(np.linspace(0, 1, len(all_pg_times)), all_bao_times, lw=3, label="Bao")

if SHOW_RG:
    ax.plot(np.linspace(0, 1, len(all_pg_times)), all_bao_rb_times, lw=3, label="Bao (w/ exploration)")

ax.grid(linestyle="--", linewidth=1)
ax.set_xlabel("Proportion of Queries")
ax.set_ylabel("Max Latency (s)")
ax.set_title("Query Latency CDF (log scale)")
```

```
ax.legend()
ax.set_yscale("log")
fig.savefig("cdf.svg")
fig
```




```
# get the last PG time for each query
pg_query_time = {}
for itm in pg_data:
    pg_query_time[itm[3]] = itm[4]

# get each Bao time
bao_query_times = defaultdict(list)
for itm in bao_data[50:]:
    bao_query_times[itm[3]].append(itm[4])

if SHOW_RG:
    # get each Bao time
    bao_rb_query_times = defaultdict(list)
    for itm in bao_rb_data[50:]:
        bao_rb_query_times[itm[3]].append(itm[4])

max_repeats = max(len(x) for x in bao_query_times.values())

def extract_q_number(x):
    return int(x[x.find("/q")+2:x.find("_", x.find("/q"))])

q_order = sorted(bao_query_times.keys(), key=extract_q_number)

grid = [bao_query_times[x] for x in q_order]

if SHOW_RG:
    grid_rb = [bao_rb_query_times[x] for x in q_order]
```

```
28
29
30 reg_data = []
31 for idx, q in enumerate(q_order):
32     if SHOW_RG:
33         reg_data.append({"Q": f"q{extract_q_number(q)}",
34                          "PG": pg_query_time[q],
35                          "Bao worst": max(grid[idx]),
36                          "Bao best": min(grid[idx]),
37                          "Bao + E worst": max(grid_rb[idx]),
38                          "Bao + E best": min(grid_rb[idx])})
39     else:
40         reg_data.append({"Q": f"q{extract_q_number(q)}",
41                  "PG": pg_query_time[q],
42                  "Bao worst": max(grid[idx]),
43                  "Bao best": min(grid[idx])})
44
45
46
47 def color_regression(col):
48     def c_for_diff(diff):
49         if diff < 2 and diff > -2:
50             return "background-color: white"
51         elif diff > 0.5:
52             return "background-color: #f27281"
53         else:
54             return "background-color: #9ee3ad"
55
56     to_r = [""]
57
58     if SHOW_RG:
59         pg, bao_worst, bao_best, bao_rg_worst, bao_rg_best = col
60     else:
61         pg, bao_worst, bao_best = col
62
63
64     to_r.append(c_for_diff(bao_worst - pg))
65     to_r.append(c_for_diff(bao_best - pg))
66
67     if SHOW_RG:
68         to_r.append(c_for_diff(bao_rg_worst - pg))
69         to_r.append(c_for_diff(bao_rg_best - pg))
70
71     return to_r
72
73 reg_data = pd.DataFrame(reg_data).set_index("Q")
74 reg_data.style.apply(color_regression, axis=1)
```

| Q | PG | Bao worst | Bao best |
|---|---|---|---|
| q1 | 146.354750 | 11.152083 | 2.252480 |
| q2 | 6.756028 | 6.802745 | 3.680193 |
| q3 | 1.719815 | 3.019237 | 1.928251 |
| q4 | 12.468914 | 2.684415 | 1.049786 |
| q5 | 1.355233 | 61.299522 | 1.492402 |
| q6 | 13.003711 | 16.656884 | 3.114637 |
| q7 | 20.877633 | 5.110508 | 3.261638 |
| q8 | 9.812491 | 5.133699 | 2.890931 |
| q9 | 5.208707 | 8.829606 | 3.160375 |
| q10 | 3.310725 | 6.022555 | 3.265636 |
| q11 | 7.624120 | 12.150571 | 3.217331 |
| q12 | 8.634105 | 4.577479 | 1.850781 |
| q13 | 7.791924 | 2.834616 | 1.827306 |
| q14 | 3.950622 | 4.897178 | 3.037341 |
| q15 | 4.051454 | 3.828447 | 1.741153 |
| q16 | 6.826008 | 9.293304 | 1.582151 |
| q17 | 2.136989 | 5.045637 | 2.193577 |
| q18 | 5.173565 | 9.820998 | 2.649791 |
| q19 | 6.456401 | 15.531782 | 5.400611 |
| q20 | 0.073363 | 0.266245 | 0.156937 |
| q21 | 0.454355 | 1.032538 | 0.389913 |
| q22 | 32.667475 | 4.279726 | 2.353897 |
| q23 | 4.222827 | 5.385329 | 4.148135 |
| q24 | 0.017404 | 0.179299 | 0.120860 |
| q25 | 1.159946 | 3.829029 | 0.867991 |
| q26 | 4.271247 | 7.731637 | 3.149728 |
| q27 | 0.224915 | 0.492096 | 0.228347 |
| q28 | 0.527010 | 1.096441 | 0.577315 |
| q29 | 0.024137 | 0.164355 | 0.065886 |
| q30 | 2.765754 | 4.504608 | 2.616653 |
| q31 | 0.498189 | 0.865881 | 0.595014 |
| q32 | 0.150102 | 0.329405 | 0.218823 |
| q33 | 0.464363 | 1.757080 | 0.614456 |
| q34 | 1.702936 | 2.594865 | 1.386199 |
| q35 | 2.268770 | 6.975632 | 2.156359 |
| q36 | 3.650698 | 34.886131 | 5.294373 |