In [585]:
```
import os
import json
import math
import pickle
import numpy as np
import pandas as pd
import plotly.express as px
import plotly.graph_objects as go
from collections import defaultdict
from plotly.subplots import make_subplots
from concurrent.futures import ThreadPoolExecutor as Pool
from config import SMACV1_ENV_NAMES, SMACV2_ENV_NAMES, MAMUJOCO_ENV_NAMES
```

In [586]:
```
ALGO_NAMES = ["BC", "IIPL", "IPLVDN", "SLMARL", "OMAPL"]
ALGO_NAMES_MAPS = {
    "BC": "BC",
    "IIPL": "IIPL",
    "IPLVDN": "IPL-VDN",
    "SLMARL": "SL-MARL",
    "OMAPL": "O-MAPL",
}

colors = px.colors.qualitative.Plotly
COLOR_MAPS = {
    "SLMARL": colors[0],
    "OMAPL": colors[1],
    "IPVDN": colors[2],
    "BC": "#feb406",
    "IIPL": "#d366ff",
}
```

In [587]:
```
def load_results(task_name, step):
    path = f"saved_results_final/{task_name}/step{step}.json"
    if not os.path.exists(path):
        print(f"Missing data for {task_name} at step {step}")
        return None
    with open(path, "r") as f:
        return json.load(f)
```

In [588]:

```python
def get_results(algos, use_llm=False):
    if use_llm:
        path = "saved_results_final/results_llm.pkl"
    else:
        path = "saved_results_final/results.pkl"
    with open(path, "rb") as f:
        data = pickle.load(f)
        data_returns = data["returns"]
        data_winrates = data["winrates"]
    return data_returns, data_winrates


    with Pool() as p:
        tasks = []
        for algo in algos:
            for env_name in MAMUJOCO_ENV_NAMES + SMACV1_ENV_NAMES + SMACV2_ENV_NAMES:
                for step in range(101):
                    for seed in range(4):
                        if use_llm:
                            if env_name in MAMUJOCO_ENV_NAMES:
                                continue
                            task_name = f"{algo}/{env_name}_llm/seed{seed}"
                        else:
                            task_name = f"{algo}/{env_name}/seed{seed}"

                        tasks.append((env_name, algo, step, p.submit(load_results, task_name, step)))

        data_returns = defaultdict(lambda: defaultdict(lambda: defaultdict(list)))
        data_winrates = defaultdict(lambda: defaultdict(lambda: defaultdict(list)))
        for env_name, algo, step, task in tasks:
            data = task.result()
            if data is None:
                continue
            data_returns[env_name][algo][step].append(data["returns"])
            if "winrates" in data:
                data_winrates[env_name][algo][step].append(data["winrates"])
    return data_returns, data_winrates
```

In [589]:
```python
def analyze(x, tag="returns"):
    if isinstance(x, float):
        return x
    ids = list(x.keys())
    x = [x[i] for i in ids[-4:]]
    if len(x) == 0:
        return "NaN"
    x = np.array(x).mean(axis=1)
    mean = np.mean(x)
    std = np.std(x)
    if tag == "returns":
        return f"{mean:.1f} ± {std:.1f}"
    else:
        return f"{100*mean:.1f} ± {100*std:.1f}"
```

In [590]:
```python
data_returns, data_winrates = get_results(ALGO_NAMES, use_llm=False)
returns_pd = pd.DataFrame(data_returns).T.rename(columns=ALGO_NAMES_MAPS)
winrates_pd = pd.DataFrame(data_winrates).T.rename(columns=ALGO_NAMES_MAPS)
```

In [591]:
```
returns_pd.applymap(analyze)
```

Out[591]:

	BC	IIPL	IPL-VDN	SL-MARL	O-MAPL
Hopper-v2	808.1 ± 39.1	782.0 ± 81.5	846.6 ± 65.4	890.0 ± 88.7	1114.4 ± 154.1
Ant-v2	1303.9 ± 122.0	1312.0 ± 155.6	1376.1 ± 142.0	1334.1 ± 150.9	1406.4 ± 163.7
HalfCheetah-v2	4119.9 ± 350.7	4028.8 ± 430.0	4287.5 ± 273.1	4233.9 ± 303.1	4382.0 ± 189.7
2c_vs_64zg	19.0 ± 1.1	19.3 ± 0.8	19.3 ± 1.1	19.2 ± 0.8	19.3 ± 1.4
5m_vs_6m	11.1 ± 2.1	10.8 ± 2.0	11.2 ± 2.0	11.1 ± 2.1	11.5 ± 2.1
6h_vs_8z	11.0 ± 0.8	10.8 ± 0.7	11.7 ± 1.0	11.8 ± 1.0	12.1 ± 1.3
corridor	19.4 ± 1.0	19.4 ± 1.0	19.6 ± 1.0	14.3 ± 2.8	19.6 ± 0.9
protoss_5_vs_5	15.4 ± 2.4	14.3 ± 2.5	17.1 ± 2.7	15.8 ± 2.7	16.8 ± 2.4
protoss_10_vs_10	16.0 ± 2.0	15.4 ± 2.1	17.8 ± 2.3	16.4 ± 2.4	17.9 ± 1.9
protoss_10_vs_11	12.5 ± 2.3	12.7 ± 2.4	14.7 ± 2.3	14.2 ± 2.2	14.9 ± 2.0
protoss_20_vs_20	16.7 ± 1.8	16.9 ± 1.6	18.0 ± 1.5	17.3 ± 1.6	18.0 ± 1.5
protoss_20_vs_23	13.3 ± 2.1	13.1 ± 1.8	14.9 ± 1.9	13.6 ± 1.9	14.9 ± 2.0
terran_5_vs_5	10.2 ± 2.9	11.2 ± 3.1	11.9 ± 3.1	13.0 ± 3.1	12.8 ± 3.5
terran_10_vs_10	10.9 ± 2.9	10.6 ± 3.0	11.6 ± 2.8	11.4 ± 2.9	11.8 ± 2.6
terran_10_vs_11	8.3 ± 2.6	8.1 ± 2.3	10.1 ± 3.0	9.6 ± 2.6	11.0 ± 2.8
terran_20_vs_20	10.1 ± 2.4	10.2 ± 2.5	10.7 ± 2.6	10.9 ± 2.2	11.8 ± 2.4
terran_20_vs_23	7.6 ± 2.1	7.0 ± 2.1	8.7 ± 2.1	7.7 ± 2.0	9.4 ± 2.0
zerg_5_vs_5	11.2 ± 2.8	10.5 ± 2.8	12.1 ± 2.7	12.7 ± 3.1	13.1 ± 3.5
zerg_10_vs_10	12.9 ± 2.4	12.4 ± 2.7	13.0 ± 2.6	13.2 ± 2.7	14.0 ± 2.6
zerg_10_vs_11	11.1 ± 2.7	10.7 ± 2.7	12.1 ± 2.5	11.8 ± 2.1	12.8 ± 2.7
zerg_20_vs_20	13.0 ± 2.2	12.2 ± 1.9	13.8 ± 2.1	12.2 ± 1.6	13.9 ± 1.8
zerg_20_vs_23	12.1 ± 2.3	11.3 ± 1.7	12.1 ± 1.8	12.2 ± 1.6	12.7 ± 2.0

In [592]:
```
winrates_pd.applymap(lambda x: analyze(x, tag="winrates"))
```

Out[592]:

	BC	IIPL	IPL-VDN	SL-MARL	O-MAPL
2c_vs_64zg	59.6 ± 25.0	60.4 ± 24.7	71.1 ± 22.0	63.5 ± 24.0	74.4 ± 24.7
5m_vs_6m	16.8 ± 18.0	14.3 ± 17.0	16.8 ± 18.0	16.0 ± 18.9	19.3 ± 19.6
6h_vs_8z	0.6 ± 3.8	0.2 ± 2.2	2.5 ± 7.6	1.6 ± 6.8	4.5 ± 11.0
corridor	89.3 ± 15.5	89.8 ± 15.4	93.9 ± 11.6	49.0 ± 22.8	93.2 ± 13.5
protoss_5_vs_5	38.1 ± 24.2	31.4 ± 25.2	54.5 ± 25.9	49.0 ± 28.2	54.3 ± 24.2
protoss_10_vs_10	38.7 ± 24.2	28.5 ± 21.8	47.9 ± 27.2	40.6 ± 23.2	53.7 ± 23.6
protoss_10_vs_11	12.7 ± 17.4	12.5 ± 16.5	22.3 ± 21.0	18.6 ± 18.8	30.7 ± 19.8
protoss_20_vs_20	39.8 ± 24.9	35.4 ± 21.5	57.0 ± 24.8	38.7 ± 23.1	59.8 ± 23.2
protoss_20_vs_23	15.2 ± 18.5	9.0 ± 14.2	22.7 ± 21.7	11.1 ± 14.6	23.4 ± 19.2
terran_5_vs_5	27.5 ± 24.0	26.2 ± 19.5	36.3 ± 24.8	34.2 ± 23.4	39.5 ± 24.7
terran_10_vs_10	23.8 ± 20.5	21.1 ± 20.8	25.8 ± 19.7	23.2 ± 19.6	28.3 ± 20.6
terran_10_vs_11	10.2 ± 15.4	7.2 ± 13.3	18.2 ± 19.4	11.3 ± 15.3	18.2 ± 18.7
terran_20_vs_20	13.1 ± 17.1	11.9 ± 18.2	21.5 ± 20.4	8.8 ± 13.5	23.0 ± 22.4
terran_20_vs_23	3.9 ± 10.6	4.1 ± 10.3	5.7 ± 11.4	2.3 ± 7.3	7.2 ± 12.9
zerg_5_vs_5	23.4 ± 21.1	23.6 ± 21.0	31.1 ± 20.4	33.0 ± 22.5	35.2 ± 25.7
zerg_10_vs_10	25.8 ± 21.6	25.8 ± 22.5	32.2 ± 24.6	30.7 ± 24.0	34.8 ± 22.1
zerg_10_vs_11	19.3 ± 20.1	12.9 ± 17.4	22.5 ± 20.5	19.3 ± 18.0	23.4 ± 21.1
zerg_20_vs_20	19.9 ± 21.0	11.1 ± 16.2	22.5 ± 21.4	5.7 ± 10.9	24.8 ± 20.8
zerg_20_vs_23	13.1 ± 17.7	7.8 ± 12.8	12.5 ± 15.3	7.6 ± 13.1	18.8 ± 18.5

In [593]:
```
data_returns_llm, data_winrates_llm = get_results(ALGO_NAMES, use_llm=True)
returns_pd_llm = pd.DataFrame(data_returns_llm).T.rename(columns=ALGO_NAMES_MAPS)
winrates_pd_llm = pd.DataFrame(data_winrates_llm).T.rename(columns=ALGO_NAMES_MAPS)
```

In [594]:
```
returns_pd_llm.applymap(analyze)
```

Out[594]:

	BC	IIPL	IPL-VDN	SL-MARL	O-MAPL
2c_vs_64zg	19.4 ± 0.9	19.3 ± 0.9	19.6 ± 1.0	19.5 ± 0.7	19.6 ± 1.1
5m_vs_6m	11.3 ± 2.1	10.8 ± 2.0	11.4 ± 2.2	11.2 ± 2.1	11.5 ± 2.3
6h_vs_8z	11.1 ± 0.8	10.9 ± 0.7	11.9 ± 1.1	11.8 ± 1.2	12.2 ± 1.3
corridor	19.4 ± 1.0	19.4 ± 1.0	19.7 ± 0.9	15.1 ± 2.4	19.7 ± 0.8
protoss_5_vs_5	16.7 ± 2.7	15.9 ± 2.5	17.6 ± 2.5	16.9 ± 2.4	17.9 ± 2.5
protoss_10_vs_10	16.5 ± 2.0	16.6 ± 2.2	17.9 ± 1.8	17.5 ± 1.8	18.0 ± 2.1
protoss_10_vs_11	14.7 ± 2.3	14.5 ± 2.0	15.4 ± 2.4	14.0 ± 2.4	16.5 ± 2.2
protoss_20_vs_20	17.2 ± 1.7	17.6 ± 1.7	18.5 ± 1.3	18.2 ± 1.9	18.9 ± 1.5
protoss_20_vs_23	14.3 ± 2.0	13.4 ± 1.8	15.1 ± 1.8	14.3 ± 1.8	15.8 ± 1.9
terran_5_vs_5	11.8 ± 3.3	12.5 ± 3.1	13.4 ± 2.9	12.6 ± 3.1	12.6 ± 2.6
terran_10_vs_10	11.3 ± 2.6	11.7 ± 3.0	11.6 ± 2.7	12.1 ± 2.8	12.5 ± 2.7
terran_10_vs_11	9.2 ± 2.8	9.3 ± 2.7	10.1 ± 2.6	9.9 ± 2.6	10.7 ± 2.5
terran_20_vs_20	11.2 ± 2.3	10.8 ± 2.5	11.4 ± 2.4	11.6 ± 2.2	13.0 ± 2.8
terran_20_vs_23	8.5 ± 2.4	7.7 ± 2.2	8.9 ± 2.1	8.7 ± 1.9	9.1 ± 2.3
zerg_5_vs_5	11.4 ± 2.7	11.6 ± 3.0	12.8 ± 3.3	11.8 ± 2.9	12.9 ± 2.6
zerg_10_vs_10	13.5 ± 2.6	13.4 ± 2.7	13.7 ± 2.5	13.7 ± 3.0	14.5 ± 2.6
zerg_10_vs_11	12.0 ± 2.3	11.9 ± 2.7	11.7 ± 2.0	12.8 ± 2.4	12.6 ± 2.5
zerg_20_vs_20	13.9 ± 2.3	13.4 ± 1.9	14.6 ± 2.0	13.8 ± 2.0	15.2 ± 2.4
zerg_20_vs_23	12.6 ± 2.0	12.1 ± 1.9	12.4 ± 2.3	12.6 ± 1.9	12.4 ± 2.2

In [595]:
```
winrates_pd_llm.applymap(lambda x: analyze(x, tag="winrates"))
```

Out[595]:

	BC	IIPL	IPL-VDN	SL-MARL	O-MAPL
2c_vs_64zg	65.6 ± 24.6	60.2 ± 25.9	77.0 ± 21.3	65.2 ± 21.2	79.5 ± 19.6
5m_vs_6m	18.2 ± 18.4	15.0 ± 17.5	18.0 ± 19.2	17.4 ± 19.4	20.7 ± 20.5
6h_vs_8z	0.8 ± 4.3	0.4 ± 3.1	3.5 ± 9.2	3.7 ± 8.9	6.1 ± 11.2
corridor	89.6 ± 15.5	90.6 ± 13.6	94.5 ± 12.5	57.6 ± 22.2	94.5 ± 11.2
protoss_5_vs_5	48.4 ± 25.9	41.0 ± 24.2	58.8 ± 24.5	54.3 ± 24.0	61.5 ± 24.8
protoss_10_vs_10	46.3 ± 24.0	41.0 ± 24.4	57.0 ± 23.4	52.5 ± 22.1	61.1 ± 24.8
protoss_10_vs_11	22.7 ± 22.2	15.6 ± 15.9	27.3 ± 24.7	20.9 ± 20.9	34.4 ± 24.8
protoss_20_vs_20	48.4 ± 25.3	43.6 ± 23.6	61.5 ± 22.1	51.8 ± 25.0	64.5 ± 23.5
protoss_20_vs_23	18.0 ± 17.4	9.4 ± 14.7	23.4 ± 21.4	12.1 ± 15.9	26.4 ± 20.8
terran_5_vs_5	31.1 ± 22.9	34.8 ± 23.0	41.0 ± 23.7	36.7 ± 24.8	43.0 ± 23.0
terran_10_vs_10	25.8 ± 20.9	24.2 ± 21.6	32.0 ± 24.4	28.9 ± 24.7	33.2 ± 23.4
terran_10_vs_11	11.7 ± 17.4	10.4 ± 15.2	17.8 ± 17.7	16.4 ± 17.8	21.3 ± 20.3
terran_20_vs_20	14.5 ± 17.3	13.7 ± 17.4	21.1 ± 20.4	17.2 ± 16.8	24.4 ± 23.1
terran_20_vs_23	6.4 ± 12.2	3.5 ± 9.2	7.2 ± 12.6	4.7 ± 10.2	8.6 ± 14.8
zerg_5_vs_5	31.1 ± 22.3	26.0 ± 22.2	34.8 ± 23.6	35.0 ± 23.2	40.8 ± 21.6
zerg_10_vs_10	31.4 ± 21.9	31.1 ± 24.8	35.5 ± 23.9	33.0 ± 25.0	37.9 ± 24.0
zerg_10_vs_11	20.1 ± 18.2	18.6 ± 20.6	22.7 ± 18.3	23.0 ± 21.1	26.0 ± 23.0
zerg_20_vs_20	22.9 ± 21.7	16.0 ± 17.3	27.3 ± 22.0	16.4 ± 18.1	31.1 ± 24.6
zerg_20_vs_23	15.8 ± 18.5	10.4 ± 15.2	16.4 ± 19.9	13.7 ± 17.4	16.0 ± 19.4

In [596]:
```
# combine columns: returns_pd & returns_pd_llm
returns_combined = pd.concat([returns_pd, returns_pd_llm], axis=1)
winrates_combined = pd.concat([winrates_pd, winrates_pd_llm], axis=1)
```

In [597]:
```
returns_combined.applymap(analyze)
```

Out[597]:

	BC	IIPL	IPL-VDN	SL-MARL	O-MAPL	BC	IIPL	IPL-VDN	SL-MARL	O-MAPL
Hopper-v2	808.1 ± 39.1	782.0 ± 81.5	846.6 ± 65.4	890.0 ± 88.7	1114.4 ± 154.1	NaN	NaN	NaN	NaN	NaN
Ant-v2	1303.9 ± 122.0	1312.0 ± 155.6	1376.1 ± 142.0	1334.1 ± 150.9	1406.4 ± 163.7	NaN	NaN	NaN	NaN	NaN
HalfCheetah-v2	4119.9 ± 350.7	4028.8 ± 430.0	4287.5 ± 273.1	4233.9 ± 303.1	4382.0 ± 189.7	NaN	NaN	NaN	NaN	NaN
2c_vs_64zg	19.0 ± 1.1	19.3 ± 0.8	19.3 ± 1.1	19.2 ± 0.8	19.3 ± 1.4	19.4 ± 0.9	19.3 ± 0.9	19.6 ± 1.0	19.5 ± 0.7	19.6 ± 1.1
5m_vs_6m	11.1 ± 2.1	10.8 ± 2.0	11.2 ± 2.0	11.1 ± 2.1	11.5 ± 2.1	11.3 ± 2.1	10.8 ± 2.0	11.4 ± 2.2	11.2 ± 2.1	11.5 ± 2.3
6h_vs_8z	11.0 ± 0.8	10.8 ± 0.7	11.7 ± 1.0	11.8 ± 1.0	12.1 ± 1.3	11.1 ± 0.8	10.9 ± 0.7	11.9 ± 1.1	11.8 ± 1.2	12.2 ± 1.3
corridor	19.4 ± 1.0	19.4 ± 1.0	19.6 ± 1.0	14.3 ± 2.8	19.6 ± 0.9	19.4 ± 1.0	19.4 ± 1.0	19.7 ± 0.9	15.1 ± 2.4	19.7 ± 0.8
protoss_5_vs_5	15.4 ± 2.4	14.3 ± 2.5	17.1 ± 2.7	15.8 ± 2.7	16.8 ± 2.4	16.7 ± 2.7	15.9 ± 2.5	17.6 ± 2.5	16.9 ± 2.4	17.9 ± 2.5
protoss_10_vs_10	16.0 ± 2.0	15.4 ± 2.1	17.8 ± 2.3	16.4 ± 2.4	17.9 ± 1.9	16.5 ± 2.0	16.6 ± 2.2	17.9 ± 1.8	17.5 ± 1.8	18.0 ± 2.1
protoss_10_vs_11	12.5 ± 2.3	12.7 ± 2.4	14.7 ± 2.3	14.2 ± 2.2	14.9 ± 2.0	14.7 ± 2.3	14.5 ± 2.0	15.4 ± 2.4	14.0 ± 2.4	16.5 ± 2.2
protoss_20_vs_20	16.7 ± 1.8	16.9 ± 1.6	18.0 ± 1.5	17.3 ± 1.6	18.0 ± 1.5	17.2 ± 1.7	17.6 ± 1.7	18.5 ± 1.3	18.2 ± 1.9	18.9 ± 1.5
protoss_20_vs_23	13.3 ± 2.1	13.1 ± 1.8	14.9 ± 1.9	13.6 ± 1.9	14.9 ± 2.0	14.3 ± 2.0	13.4 ± 1.8	15.1 ± 1.8	14.3 ± 1.8	15.8 ± 1.9
terran_5_vs_5	10.2 ± 2.9	11.2 ± 3.1	11.9 ± 3.1	13.0 ± 3.1	12.8 ± 3.5	11.8 ± 3.3	12.5 ± 3.1	13.4 ± 2.9	12.6 ± 3.1	12.6 ± 2.6
terran_10_vs_10	10.9 ± 2.9	10.6 ± 3.0	11.6 ± 2.8	11.4 ± 2.9	11.8 ± 2.6	11.3 ± 2.6	11.7 ± 3.0	11.6 ± 2.7	12.1 ± 2.8	12.5 ± 2.7
terran_10_vs_11	8.3 ± 2.6	8.1 ± 2.3	10.1 ± 3.0	9.6 ± 2.6	11.0 ± 2.8	9.2 ± 2.8	9.3 ± 2.7	10.1 ± 2.6	9.9 ± 2.6	10.7 ± 2.5
terran_20_vs_20	10.1 ± 2.4	10.2 ± 2.5	10.7 ± 2.6	10.9 ± 2.2	11.8 ± 2.4	11.2 ± 2.3	10.8 ± 2.5	11.4 ± 2.4	11.6 ± 2.2	13.0 ± 2.8
terran_20_vs_23	7.6 ± 2.1	7.0 ± 2.1	8.7 ± 2.1	7.7 ± 2.0	9.4 ± 2.0	8.5 ± 2.4	7.7 ± 2.2	8.9 ± 2.1	8.7 ± 1.9	9.1 ± 2.3
zerg_5_vs_5	11.2 ± 2.8	10.5 ± 2.8	12.1 ± 2.7	12.7 ± 3.1	13.1 ± 3.5	11.4 ± 2.7	11.6 ± 3.0	12.8 ± 3.3	11.8 ± 2.9	12.9 ± 2.6
zerg_10_vs_10	12.9 ± 2.4	12.4 ± 2.7	13.0 ± 2.6	13.2 ± 2.7	14.0 ± 2.6	13.5 ± 2.6	13.4 ± 2.7	13.7 ± 2.5	13.7 ± 3.0	14.5 ± 2.6
zerg_10_vs_11	11.1 ± 2.7	10.7 ± 2.7	12.1 ± 2.5	11.8 ± 2.1	12.8 ± 2.7	12.0 ± 2.3	11.9 ± 2.7	11.7 ± 2.0	12.8 ± 2.4	12.6 ± 2.5
zerg_20_vs_20	13.0 ± 2.2	12.2 ± 1.9	13.8 ± 2.1	12.2 ± 1.6	13.9 ± 1.8	13.9 ± 2.3	13.4 ± 1.9	14.6 ± 2.0	13.8 ± 2.0	15.2 ± 2.4
zerg_20_vs_23	12.1 ± 2.3	11.3 ± 1.7	12.1 ± 1.8	12.2 ± 1.6	12.7 ± 2.0	12.6 ± 2.0	12.1 ± 1.9	12.4 ± 2.3	12.6 ± 1.9	12.4 ± 2.2

In [598]:
```
winrates_combined.applymap(lambda x: analyze(x, tag="winrates"))
```

Out[598]:

	BC	IIPL	IPL-VDN	SL-MARL	O-MAPL	BC	IIPL	IPL-VDN	SL-MARL	O-MAPL
2c_vs_64zg	59.6 ± 25.0	60.4 ± 24.7	71.1 ± 22.0	63.5 ± 24.0	74.4 ± 24.7	65.6 ± 24.6	60.2 ± 25.9	77.0 ± 21.3	65.2 ± 21.2	79.5 ± 19.6
5m_vs_6m	16.8 ± 18.0	14.3 ± 17.0	16.8 ± 18.0	16.0 ± 18.9	19.3 ± 19.6	18.2 ± 18.4	15.0 ± 17.5	18.0 ± 19.2	17.4 ± 19.4	20.7 ± 20.5
6h_vs_8z	0.6 ± 3.8	0.2 ± 2.2	2.5 ± 7.6	1.6 ± 6.8	4.5 ± 11.0	0.8 ± 4.3	0.4 ± 3.1	3.5 ± 9.2	3.7 ± 8.9	6.1 ± 11.2
corridor	89.3 ± 15.5	89.8 ± 15.4	93.9 ± 11.6	49.0 ± 22.8	93.2 ± 13.5	89.6 ± 15.5	90.6 ± 13.6	94.5 ± 12.5	57.6 ± 22.2	94.5 ± 11.2
protoss_5_vs_5	38.1 ± 24.2	31.4 ± 25.2	54.5 ± 25.9	49.0 ± 28.2	54.3 ± 24.2	48.4 ± 25.9	41.0 ± 24.2	58.8 ± 24.5	54.3 ± 24.0	61.5 ± 24.8
protoss_10_vs_10	38.7 ± 24.2	28.5 ± 21.8	47.9 ± 27.2	40.6 ± 23.2	53.7 ± 23.6	46.3 ± 24.0	41.0 ± 24.4	57.0 ± 23.4	52.5 ± 22.1	61.1 ± 24.8
protoss_10_vs_11	12.7 ± 17.4	12.5 ± 16.5	22.3 ± 21.0	18.6 ± 18.8	30.7 ± 19.8	22.7 ± 22.2	15.6 ± 15.9	27.3 ± 24.7	20.9 ± 20.9	34.4 ± 24.8
protoss_20_vs_20	39.8 ± 24.9	35.4 ± 21.5	57.0 ± 24.8	38.7 ± 23.1	59.8 ± 23.2	48.4 ± 25.3	43.6 ± 23.6	61.5 ± 22.1	51.8 ± 25.0	64.5 ± 23.5
protoss_20_vs_23	15.2 ± 18.5	9.0 ± 14.2	22.7 ± 21.7	11.1 ± 14.6	23.4 ± 19.2	18.0 ± 17.4	9.4 ± 14.7	23.4 ± 21.4	12.1 ± 15.9	26.4 ± 20.8
terran_5_vs_5	27.5 ± 24.0	26.2 ± 19.5	36.3 ± 24.8	34.2 ± 23.4	39.5 ± 24.7	31.1 ± 22.9	34.8 ± 23.0	41.0 ± 23.7	36.7 ± 24.8	43.0 ± 23.0
terran_10_vs_10	23.8 ± 20.5	21.1 ± 20.8	25.8 ± 19.7	23.2 ± 19.6	28.3 ± 20.6	25.8 ± 20.9	24.2 ± 21.6	32.0 ± 24.4	28.9 ± 24.7	33.2 ± 23.4
terran_10_vs_11	10.2 ± 15.4	7.2 ± 13.3	18.2 ± 19.4	11.3 ± 15.3	18.2 ± 18.7	11.7 ± 17.4	10.4 ± 15.2	17.8 ± 17.7	16.4 ± 17.8	21.3 ± 20.3
terran_20_vs_20	13.1 ± 17.1	11.9 ± 18.2	21.5 ± 20.4	8.8 ± 13.5	23.0 ± 22.4	14.5 ± 17.3	13.7 ± 17.4	21.1 ± 20.4	17.2 ± 16.8	24.4 ± 23.1
terran_20_vs_23	3.9 ± 10.6	4.1 ± 10.3	5.7 ± 11.4	2.3 ± 7.3	7.2 ± 12.9	6.4 ± 12.2	3.5 ± 9.2	7.2 ± 12.6	4.7 ± 10.2	8.6 ± 14.8
zerg_5_vs_5	23.4 ± 21.1	23.6 ± 21.0	31.1 ± 20.4	33.0 ± 22.5	35.2 ± 25.7	31.1 ± 22.3	26.0 ± 22.2	34.8 ± 23.6	35.0 ± 23.2	40.8 ± 21.6
zerg_10_vs_10	25.8 ± 21.6	25.8 ± 22.5	32.2 ± 24.6	30.7 ± 24.0	34.8 ± 22.1	31.4 ± 21.9	31.1 ± 24.8	35.5 ± 23.9	33.0 ± 25.0	37.9 ± 24.0
zerg_10_vs_11	19.3 ± 20.1	12.9 ± 17.4	22.5 ± 20.5	19.3 ± 18.0	23.4 ± 21.1	20.1 ± 18.2	18.6 ± 20.6	22.7 ± 18.3	23.0 ± 21.1	26.0 ± 23.0
zerg_20_vs_20	19.9 ± 21.0	11.1 ± 16.2	22.5 ± 21.4	5.7 ± 10.9	24.8 ± 20.8	22.9 ± 21.7	16.0 ± 17.3	27.3 ± 22.0	16.4 ± 18.1	31.1 ± 24.6
zerg_20_vs_23	13.1 ± 17.7	7.8 ± 12.8	12.5 ± 15.3	7.6 ± 13.1	18.8 ± 18.5	15.8 ± 18.5	10.4 ± 15.2	16.4 ± 19.9	13.7 ± 17.4	16.0 ± 19.4

In [599]:
```
def smooth(scalars, weight):
    last = 0
    smoothed = []
    for num_acc, next_val in enumerate(scalars):
        last = last * weight + (1 - weight) * next_val
        smoothed.append(last / (1 - math.pow(weight, num_acc+1)))
    return smoothed
```

In [600]:

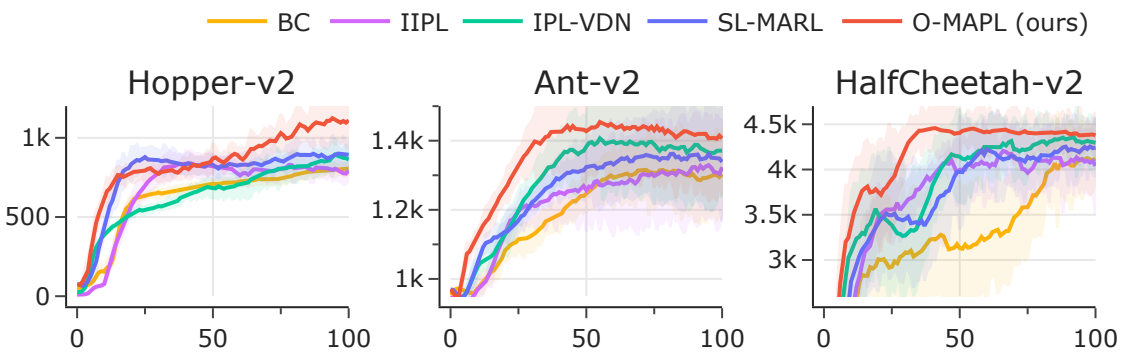
```
def create_scatters(env_name, data_dict, y_range=None, tag="returns"):
    fig = go.Figure()
    for algo in ALGO_NAMES:
        steps = []
        values = []
        stds = []
        for step in range(101):
            data = np.array(data_dict[env_name][algo][step]).mean(axis=0)
            steps.append(step)
            values.append(data.mean())
            stds.append(data.std())
        smooth_weight = 0.8
        if env_name in SMACV1_ENV_NAMES and tag == "returns":
            smooth_weight = 0.7
        values = smooth(values, smooth_weight)

        uppers = [value + std for value, std in zip(values, stds)]
        lowers = [value - std for value, std in zip(values, stds)]

        if tag == "winrates":
            uppers = [min(1.0, value) for value in uppers]
            lowers = [max(0.0, value) for value in lowers]

        color = COLOR_MAPS.get(algo, colors[2])
        algo_name = ALGO_NAMES_MAPS.get(algo, algo)
        if algo_name == "O-MAPL":
            algo_name = "O-MAPL (ours)"

        opacity = 0.1
        fig.add_trace(go.Scatter(x=steps, y=values, mode="lines", name=algo_name, line_color=color, line_width=2.
0))
        fig.add_trace(go.Scatter(x=steps+steps[::-1], y=uppers+lowers[::-1], fill="toself", fillcolor=color, line_c
olor=color, opacity=opacity, line_width=1.5, showlegend=False))

    if tag == "winrates":
        tickformat = ".0%"
    else:
        tickformat = "~s"

    fig.update_layout(template='simple_white', margin=dict(l=0, r=0, t=0, b=0, pad=0, autoexpand=True))
    fig.update_layout(height=100, width=180)
    fig.update_xaxes(range=[0, 100], dtick=50, minor=dict(ticklen=3, nticks=4))
    fig.update_yaxes(range=y_range, tickformat=tickformat)
    return fig
```

In [601]:
```
def update_legend(fig, tag="returns", distance=1.1, yrange=None, left_margin=0, right_margin=15, bottom_margin=0):
    trace_names = []
    for trace in fig.data:
        if trace.name is not None and trace.name not in trace_names:
            trace_names.append(trace.name)
            trace.update(showlegend=True)
        else:
            trace.update(showlegend=False)
    fig.update_layout(template='simple_white', margin=dict(l=left_margin, r=right_margin, t=0, b=bottom_margin, pad
=5, autoexpand=True))
    fig.update_layout(legend=dict(orientation="h", yanchor="bottom", y=distance, xanchor="right", x=1))

    fig.update_xaxes(showgrid=True)
    fig.update_yaxes(showgrid=True)

    fig.update_xaxes(range=[0, 100], dtick=50, minor=dict(ticklen=3, nticks=3))


    if tag == "winrates":
        # fig.update_yaxes(range=[0, 0.99], tickformat=".0%", dtick=0.4, minor=dict(ticklen=3, nticks=2))
        fig.update_yaxes(tickformat=".0%", minor=dict(ticklen=3, nticks=2))
    else:
        fig.update_yaxes(tickformat="~s", minor=dict(ticklen=3, nticks=2))
    if yrange is not None:
        fig.update_yaxes(range=yrange)
    return fig
```

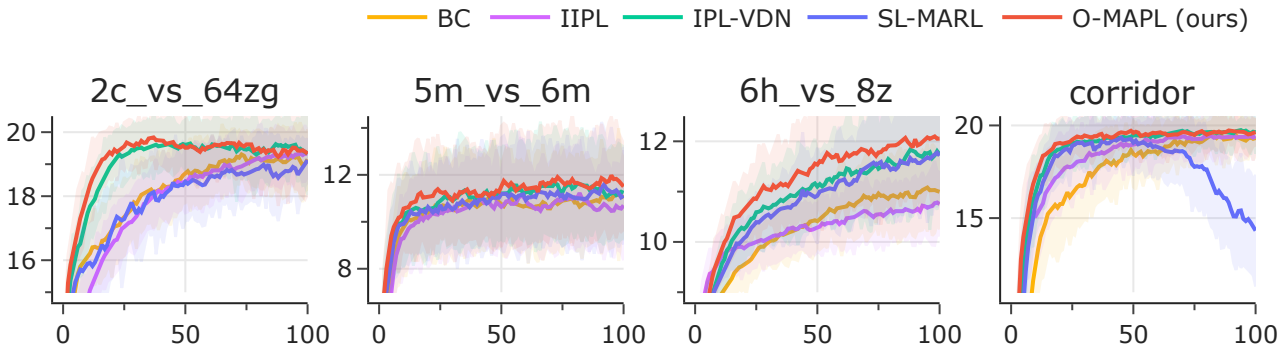
In [602]:
```
plotly_figs = {}
for env_name in MAMUJOCO_ENV_NAMES + SMACV1_ENV_NAMES + SMACV2_ENV_NAMES:
    plotly_figs[env_name] = create_scatters(env_name, data_returns)
```

In [603]:

```
fig = make_subplots(rows=1, cols=3, subplot_titles=MAMUJOCO_ENV_NAMES, horizontal_spacing=0.1)
for i, env_name in enumerate(MAMUJOCO_ENV_NAMES):
    plotly_fig = plotly_figs[env_name]
    fig.add_traces(plotly_fig.data, rows=1, cols=i+1)
fig.update_layout(template='simple_white')
fig.update_layout(height=180, width=560)
fig = update_legend(fig, distance=1.3)
fig.update_yaxes(range=[0, 1200], row=1, col=1)
fig.update_yaxes(range=[950, 1500], row=1, col=2)
fig.update_yaxes(range=[2600, 4700], row=1, col=3)
fig.show("svg")
fig.write_image("graphs/mujoco_returns.pdf")
```

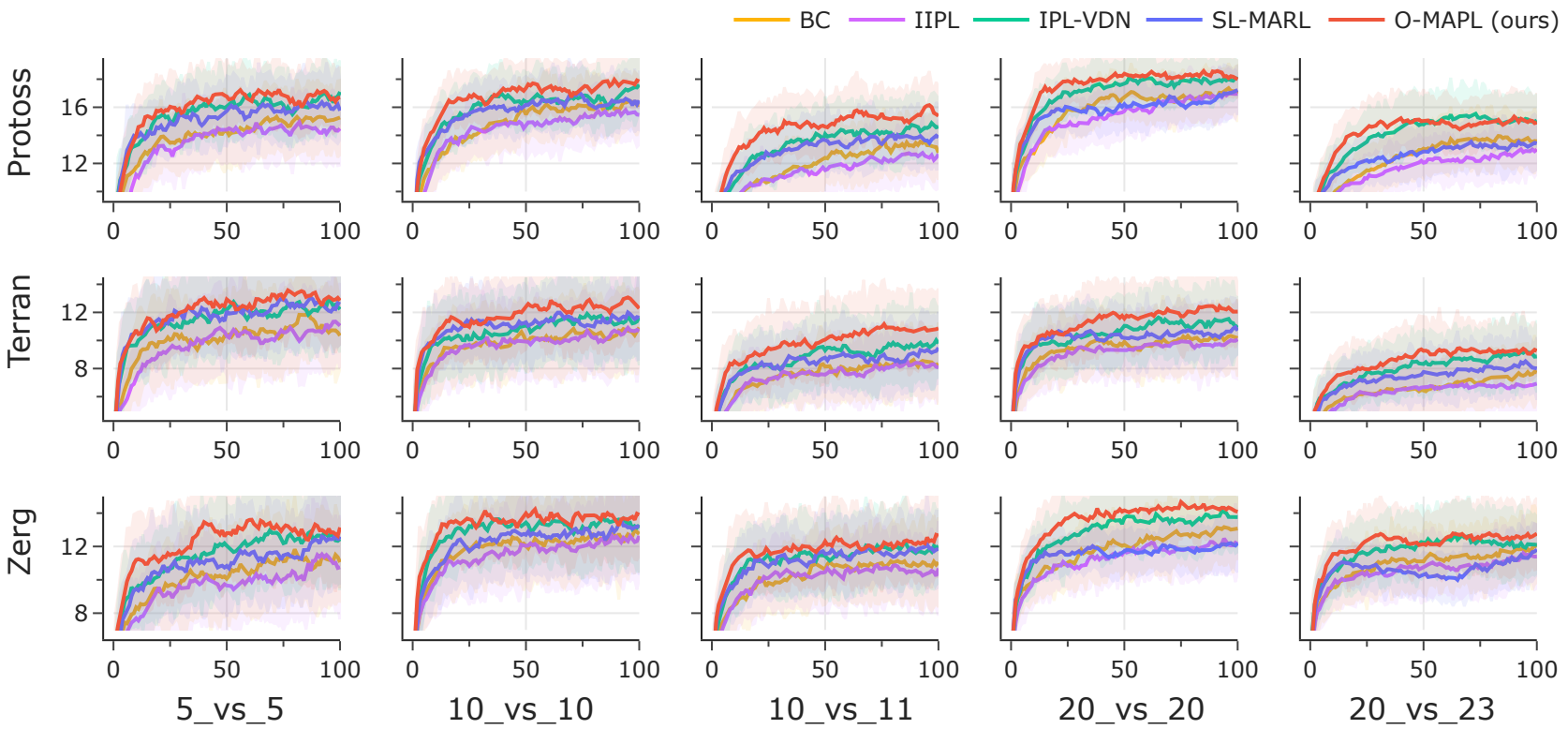


In [604]:
```
fig = make_subplots(rows=1, cols=4, subplot_titles=SMACV1_ENV_NAMES, horizontal_spacing=0.06)
for i, env_name in enumerate(SMACV1_ENV_NAMES):
    plotly_fig = plotly_figs[env_name]
    fig.add_traces(plotly_fig.data, rows=1, cols=i+1)
fig.update_layout(template='simple_white')
fig.update_layout(height=180, width=640)
fig = update_legend(fig, distance=1.4)
fig.update_yaxes(range=[15, 20.5], dtick=2, row=1, col=1)
fig.update_yaxes(range=[7, 14.5], dtick=4, row=1, col=2)
fig.update_yaxes(range=[9, 12.5], dtick=2, row=1, col=3)
fig.update_yaxes(range=[11, 20.5], dtick=5, row=1, col=4)
fig.show("svg")
fig.write_image("graphs/smacv1_returns.pdf")
```



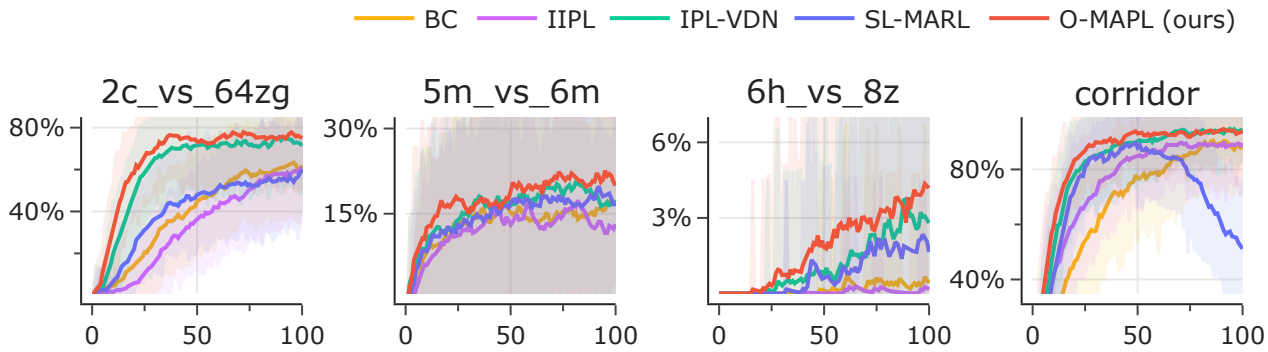
In [605]:

```
fig = make_subplots(
    rows=3, cols=5,
    column_titles=["5_vs_5", "10_vs_10", "10_vs_11", "20_vs_20", "20_vs_23"],
    row_titles=["Protoss", "Terran", "Zerg"],
    horizontal_spacing=0.05,
    vertical_spacing=0.15
)

for i, mode in enumerate(["5_vs_5", "10_vs_10", "10_vs_11", "20_vs_20", "20_vs_23"]):
    for j, env_name in enumerate(["protoss", "terran", "zerg"]):
        plotly_fig = plotly_figs[f"{env_name}_{mode}"]
        fig.add_traces(plotly_fig.data, rows=j+1, cols=i+1)

annotations = []
for i, row_title in enumerate(["Protoss", "Terran", "Zerg"]):
    annotations.append(dict(
        text=row_title,
        x=-0.065,
        y=1 - (i / 3 + 1 / 6) - 0.05 if i in [0, 1] else 1 - (i / 3 + 1 / 6 + 0.08),
        showarrow=False,
        textangle=270
    ))

for i, col_title in enumerate(["5_vs_5", "10_vs_10", "10_vs_11", "20_vs_20", "20_vs_23"]):
    annotations.append(dict(
        text=col_title,
        x=(i / 5 + 0.08) if i in [0, 1] else (i / 5 + 0.05),
        y=-0.18 if i in [0, 1] else -0.14,
        showarrow=False,
        textangle=0
    ))

fig.update_layout(annotations=annotations)
fig.update_layout(template='simple_white')
fig.update_layout(height=400, width=850)
fig = update_legend(fig, distance=1.02, left_margin=60, bottom_margin=60)
for i in range(5):
    fig.update_yaxes(range=[10, 19.5], dtick=4, row=1, col=i+1, showticklabels=i==0)
    fig.update_yaxes(range=[5, 14.5], dtick=4, row=2, col=i+1, showticklabels=i==0)
    fig.update_yaxes(range=[7, 15], dtick=4, row=3, col=i+1, showticklabels=i==0)

fig.show("svg")
fig.write_image("graphs/smacv2_returns.pdf")
```



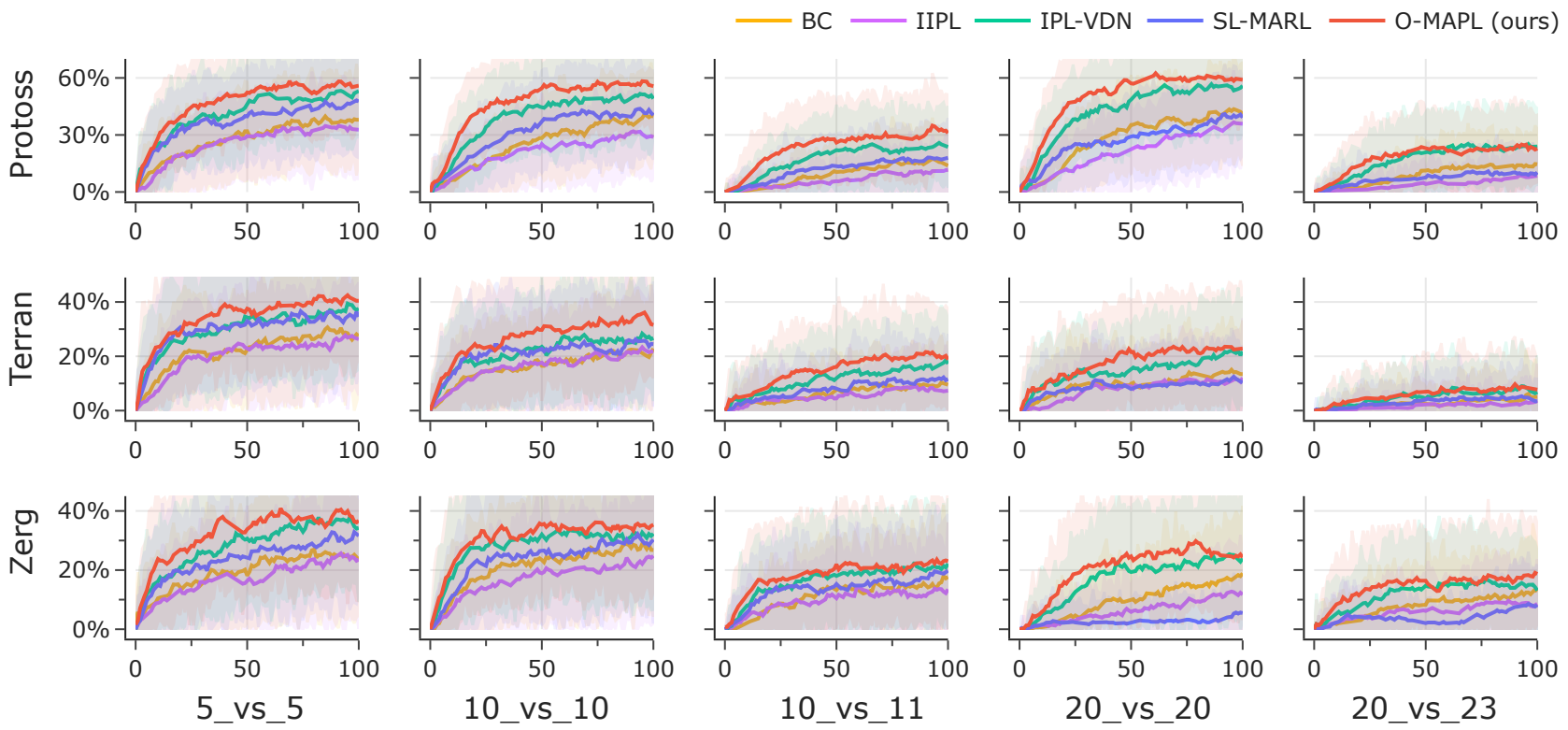
In [606]:
```
plotly_figs = {}
for env_name in SMACV1_ENV_NAMES + SMACV2_ENV_NAMES:
    plotly_figs[env_name] = create_scatters(env_name, data_winrates, tag="winrates")
```

In [607]:
```
fig = make_subplots(rows=1, cols=4, subplot_titles=SMACV1_ENV_NAMES, horizontal_spacing=0.09)
for i, env_name in enumerate(SMACV1_ENV_NAMES):
    plotly_fig = plotly_figs[env_name]
    fig.add_traces(plotly_fig.data, rows=1, cols=i+1)
fig.update_layout(template='simple_white')
fig.update_layout(height=180, width=640)
fig = update_legend(fig, distance=1.4, tag="winrates", left_margin=50)
fig.update_yaxes(range=[0.01, 0.85], dtick=0.4, row=1, col=1)
fig.update_yaxes(range=[0.01, 0.32], dtick=0.15, row=1, col=2)
fig.update_yaxes(range=[0.0001, 0.07], dtick=0.03, row=1, col=3)
fig.update_yaxes(range=[0.35, 0.99], dtick=0.4, row=1, col=4)
fig.show("svg")
fig.write_image("graphs/smacv1_winrates.pdf")
```



In [608]:

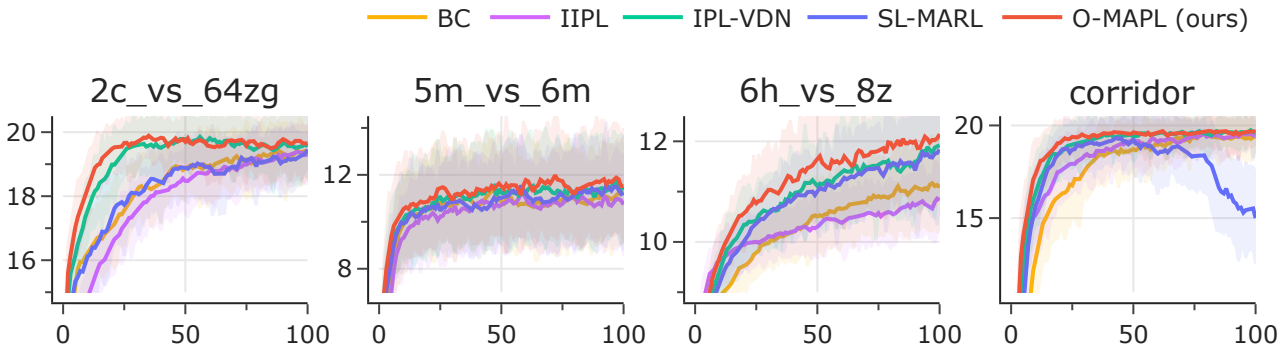
```
fig = make_subplots(
    rows=3, cols=5,
    column_titles=["5_vs_5", "10_vs_10", "10_vs_11", "20_vs_20", "20_vs_23"],
    row_titles=["Protoss", "Terran", "Zerg"],
    horizontal_spacing=0.05,
    vertical_spacing=0.15
)

for i, mode in enumerate(["5_vs_5", "10_vs_10", "10_vs_11", "20_vs_20", "20_vs_23"]):
    for j, env_name in enumerate(["protoss", "terran", "zerg"]):
        plotly_fig = plotly_figs[f"{env_name}_{mode}"]
        fig.add_traces(plotly_fig.data, rows=j+1, cols=i+1)

annotations = []
for i, row_title in enumerate(["Protoss", "Terran", "Zerg"]):
    annotations.append(dict(
        text=row_title,
        x=-0.08,
        y=1 - (i / 3 + 1 / 6) - 0.05 if i in [0] else 1 - (i / 3 + 1 / 6) - 0.08,
        showarrow=False,
        textangle=270
    ))

for i, col_title in enumerate(["5_vs_5", "10_vs_10", "10_vs_11", "20_vs_20", "20_vs_23"]):
    annotations.append(dict(
        text=col_title,
        x=(i / 5 + 0.08) if i in [0, 1] else (i / 5 + 0.05),
        y=-0.18 if i in [0, 1] else -0.14,
        showarrow=False,
        textangle=0
    ))

fig.update_layout(annotations=annotations)
fig.update_layout(template='simple_white')
fig.update_layout(height=400, width=850)
fig = update_legend(fig, tag="winrates", distance=1.02, left_margin=70, bottom_margin=60)
for i in range(5):
    fig.update_yaxes(range=[0, 0.7], dtick=0.3, row=1, col=i+1, showticklabels=i==0)
    fig.update_yaxes(range=[0, 0.49], dtick=0.2, row=2, col=i+1, showticklabels=i==0)
    fig.update_yaxes(range=[0, 0.45], dtick=0.2, row=3, col=i+1, showticklabels=i==0)
fig.show("svg")
fig.write_image("graphs/smacv2_winrates.pdf")
```



In [609]:
```
plotly_figs = {}
for env_name in SMACV1_ENV_NAMES + SMACV2_ENV_NAMES:
    plotly_figs[env_name] = create_scatters(env_name, data_returns_llm)
```

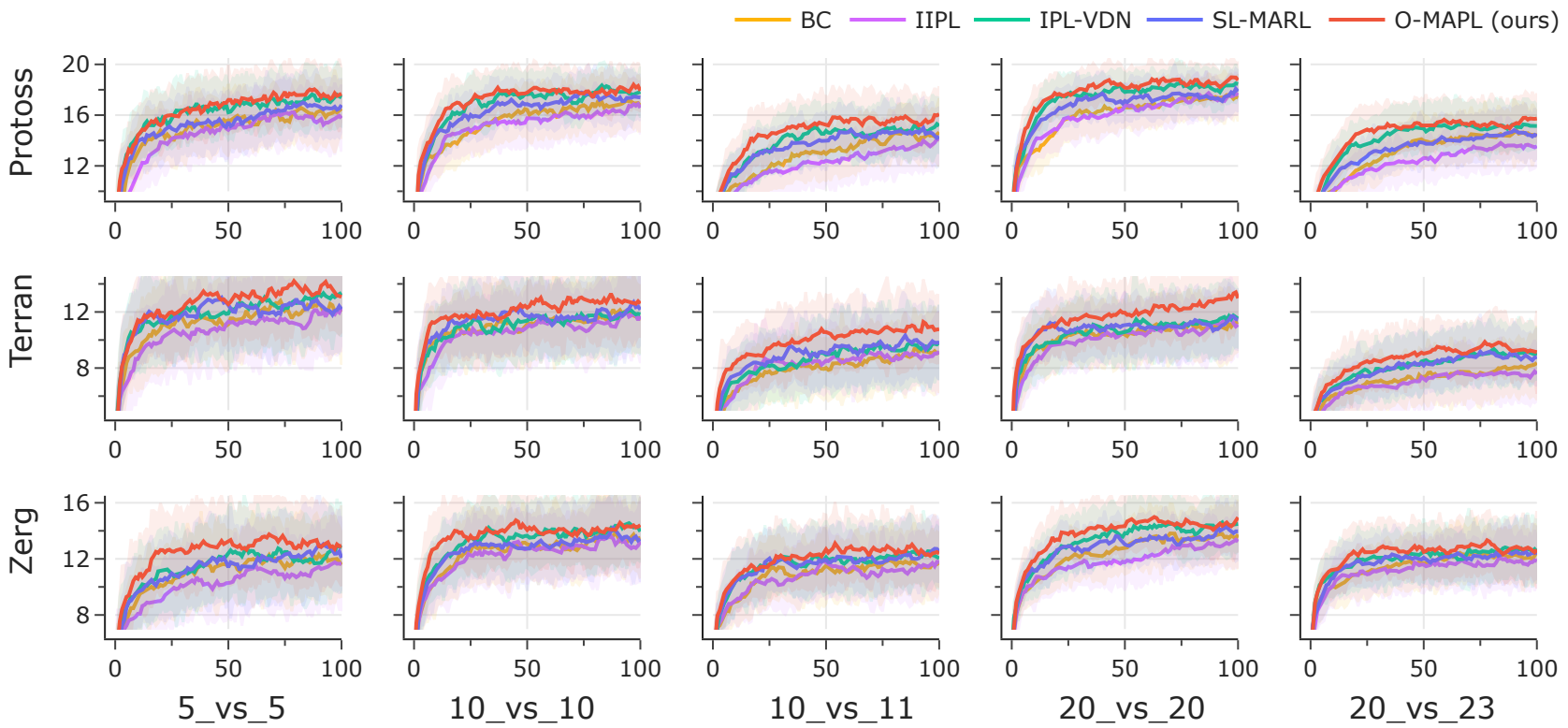
In [610]:

```
fig = make_subplots(rows=1, cols=4, subplot_titles=SMACV1_ENV_NAMES, horizontal_spacing=0.06)
for i, env_name in enumerate(SMACV1_ENV_NAMES):
    plotly_fig = plotly_figs[env_name]
    fig.add_traces(plotly_fig.data, rows=1, cols=i+1)
fig.update_layout(template='simple_white')
fig.update_layout(height=180, width=640)
fig = update_legend(fig, distance=1.4)
fig.update_yaxes(range=[15, 20.5], dtick=2, row=1, col=1)
fig.update_yaxes(range=[7, 14.5], dtick=4, row=1, col=2)
fig.update_yaxes(range=[9, 12.5], dtick=2, row=1, col=3)
fig.update_yaxes(range=[11, 20.5], dtick=5, row=1, col=4)
fig.show("svg")
fig.write_image("graphs/smacv1_returns_llm.pdf")
```



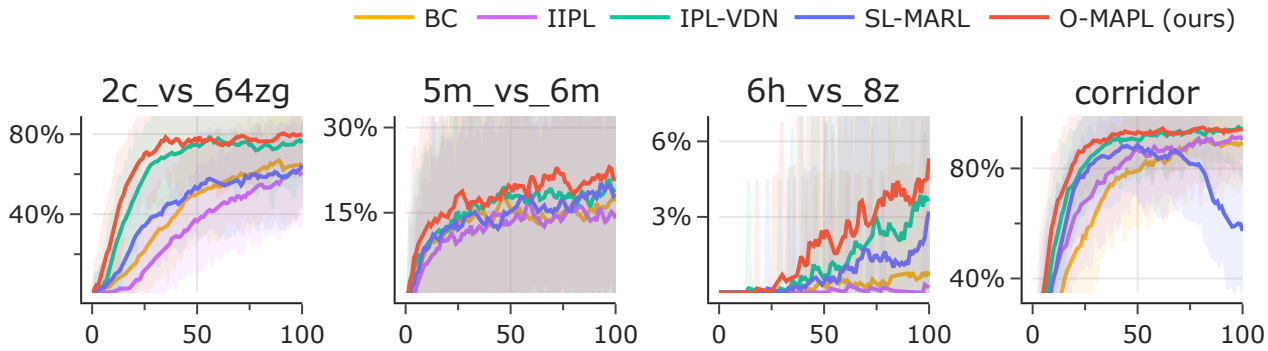
In [611]:

```
fig = make_subplots(
    rows=3, cols=5,
    column_titles=["5_vs_5", "10_vs_10", "10_vs_11", "20_vs_20", "20_vs_23"],
    row_titles=["Protoss", "Terran", "Zerg"],
    horizontal_spacing=0.05,
    vertical_spacing=0.15
)

for i, mode in enumerate(["5_vs_5", "10_vs_10", "10_vs_11", "20_vs_20", "20_vs_23"]):
    for j, env_name in enumerate(["protoss", "terran", "zerg"]):
        plotly_fig = plotly_figs[f"{env_name}_{mode}"]
        fig.add_traces(plotly_fig.data, rows=j+1, cols=i+1)

annotations = []
for i, row_title in enumerate(["Protoss", "Terran", "Zerg"]):
    annotations.append(dict(
        text=row_title,
        x=-0.065,
        y=1 - (i / 3 + 1 / 6) - 0.05 if i in [0, 1] else 1 - (i / 3 + 1 / 6 + 0.08),
        showarrow=False,
        textangle=270
    ))

for i, col_title in enumerate(["5_vs_5", "10_vs_10", "10_vs_11", "20_vs_20", "20_vs_23"]):
    annotations.append(dict(
        text=col_title,
        x=(i / 5 + 0.08) if i in [0, 1] else (i / 5 + 0.05),
        y=-0.18 if i in [0, 1] else -0.14,
        showarrow=False,
        textangle=0
    ))

fig.update_layout(annotations=annotations)
fig.update_layout(template='simple_white')
fig.update_layout(height=400, width=850)
fig = update_legend(fig, distance=1.02, left_margin=60, bottom_margin=60)
for i in range(5):
    fig.update_yaxes(range=[10, 20.5], dtick=4, row=1, col=i+1, showticklabels=i==0)
    fig.update_yaxes(range=[5, 14.5], dtick=4, row=2, col=i+1, showticklabels=i==0)
    fig.update_yaxes(range=[7, 16.5], dtick=4, row=3, col=i+1, showticklabels=i==0)

fig.show("svg")
fig.write_image("graphs/smacv2_returns_llm.pdf")
```



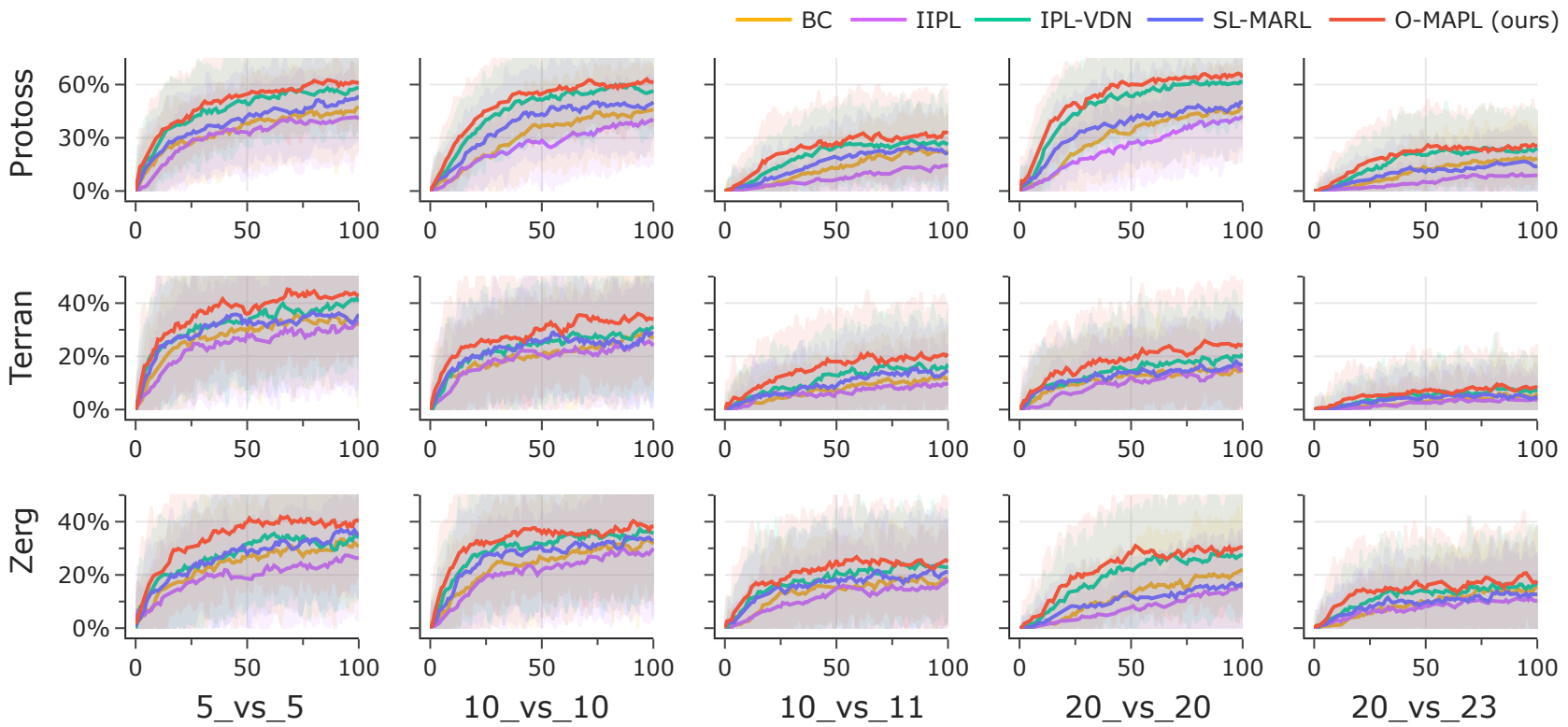
In [612]:
```
plotly_figs = {}
for env_name in SMACV1_ENV_NAMES + SMACV2_ENV_NAMES:
    plotly_figs[env_name] = create_scatters(env_name, data_winrates_llm, tag="winrates")
```

In [613]:
```
fig = make_subplots(rows=1, cols=4, subplot_titles=SMACV1_ENV_NAMES, horizontal_spacing=0.09)
for i, env_name in enumerate(SMACV1_ENV_NAMES):
    plotly_fig = plotly_figs[env_name]
    fig.add_traces(plotly_fig.data, rows=1, cols=i+1)
fig.update_layout(template='simple_white')
fig.update_layout(height=180, width=640)
fig = update_legend(fig, distance=1.4, tag="winrates", left_margin=50)
fig.update_yaxes(range=[0.01, 0.89], dtick=0.4, row=1, col=1)
fig.update_yaxes(range=[0.01, 0.32], dtick=0.15, row=1, col=2)
fig.update_yaxes(range=[0.0001, 0.07], dtick=0.03, row=1, col=3)
fig.update_yaxes(range=[0.35, 0.99], dtick=0.4, row=1, col=4)
fig.show("svg")
fig.write_image("graphs/smacv1_winrates_llm.pdf")
```



In [614]:

```
fig = make_subplots(
    rows=3, cols=5,
    column_titles=["5_vs_5", "10_vs_10", "10_vs_11", "20_vs_20", "20_vs_23"],
    row_titles=["Protoss", "Terran", "Zerg"],
    horizontal_spacing=0.05,
    vertical_spacing=0.15
)

for i, mode in enumerate(["5_vs_5", "10_vs_10", "10_vs_11", "20_vs_20", "20_vs_23"]):
    for j, env_name in enumerate(["protoss", "terran", "zerg"]):
        plotly_fig = plotly_figs[f"{env_name}_{mode}"]
        fig.add_traces(plotly_fig.data, rows=j+1, cols=i+1)

annotations = []
for i, row_title in enumerate(["Protoss", "Terran", "Zerg"]):
    annotations.append(dict(
        text=row_title,
        x=-0.08,
        y=1 - (i / 3 + 1 / 6) - 0.05 if i in [0] else 1 - (i / 3 + 1 / 6) - 0.08,
        showarrow=False,
        textangle=270
    ))

for i, col_title in enumerate(["5_vs_5", "10_vs_10", "10_vs_11", "20_vs_20", "20_vs_23"]):
    annotations.append(dict(
        text=col_title,
        x=(i / 5 + 0.08) if i in [0, 1] else (i / 5 + 0.05),
        y=-0.18 if i in [0, 1] else -0.14,
        showarrow=False,
        textangle=0
    ))

fig.update_layout(annotations=annotations)
fig.update_layout(template='simple_white')
fig.update_layout(height=400, width=850)
fig = update_legend(fig, tag="winrates", distance=1.02, left_margin=70, bottom_margin=60)
for i in range(5):
    fig.update_yaxes(range=[0, 0.75], dtick=0.3, row=1, col=i+1, showticklabels=i==0)
    fig.update_yaxes(range=[0, 0.5], dtick=0.2, row=2, col=i+1, showticklabels=i==0)
    fig.update_yaxes(range=[0, 0.5], dtick=0.2, row=3, col=i+1, showticklabels=i==0)
fig.show("svg")
fig.write_image("graphs/smacv2_winrates_llm.pdf")
```



In [615]:
```
import h5py
```

In [616]:
```
for env_name in MAMUJOCO_ENV_NAMES + SMACV1_ENV_NAMES + SMACV2_ENV_NAMES:
    with h5py.File(f"dataset/{env_name}.h5", "r") as f:
        ob_dim = f["obs_x"].shape[-1]
        st_dim = f["states_x"].shape[-1]
        ac_dim = f["actions_x"].shape[-1] if env_name in MAMUJOCO_ENV_NAMES else f["avails_x"].shape[-1]

        n_samples = f["obs_x"].shape[0]
        max_len = f["obs_x"].shape[1] - 1

        returns = np.append(np.sum(f["rewards_x"], 1), np.sum(f["rewards_y"], 1))
        file_size = os.path.getsize(f"dataset/{env_name}.h5") / (1024 ** 2)

        data = [env_name, st_dim, ob_dim, ac_dim, n_samples, max_len, f"{returns.mean():.2f} ± {returns.std():.2
f}", f"{file_size:.0f} MB"]

        print("\t".join([str(x) for x in data]))
```

```
Hopper-v2       42      14      1       1000    1000    1354.04 ± 1121.60       255 MB
Ant-v2  226     113     4       1000    1000    1514.98 ± 435.85        1003 MB
HalfCheetah-v2  138     23      1       1000    1000    1640.52 ± 1175.78       1802 MB
2c_vs_64zg      1350    478     70      2000    280     13.99 ± 4.75    401 MB
5m_vs_6m        780     124     12      2000    36      13.26 ± 5.02    72 MB
6h_vs_8z        1278    172     14      2000    48      13.01 ± 3.95    182 MB
corridor        2610    346     30      2000    394     12.69 ± 6.30    979 MB
protoss_5_vs_5  130     92      11      2000    142     16.07 ± 4.94    56 MB
protoss_10_vs_10        310     182     16      2000    178     15.72 ± 4.28    209 MB
protoss_10_vs_11        327     191     17      2000    146     15.45 ± 4.85    218 MB
protoss_20_vs_20        820     362     26      2000    200     15.63 ± 4.76    726 MB
protoss_20_vs_23        901     389     29      2000    200     14.44 ± 4.73    799 MB
terran_5_vs_5   120     82      11      2000    200     16.20 ± 6.37    44 MB
terran_10_vs_10 290     162     16      2000    200     14.86 ± 5.78    151 MB
terran_10_vs_11 306     170     17      2000    200     13.52 ± 5.44    165 MB
terran_20_vs_20 780     322     26      2000    200     13.52 ± 5.76    530 MB
terran_20_vs_23 858     346     29      2000    200     10.67 ± 5.11    563 MB
zerg_5_vs_5     120     82      11      2000    57      14.79 ± 7.70    31 MB
zerg_10_vs_10   290     162     16      2000    70      14.61 ± 5.63    99 MB
zerg_10_vs_11   306     170     17      2000    104     13.67 ± 5.71    101 MB
zerg_20_vs_20   780     322     26      2000    134     12.14 ± 3.95    303 MB
zerg_20_vs_23   858     346     29      2000    99      10.88 ± 4.36    313 MB
```

In [617]:
```
for env_name in SMACV1_ENV_NAMES + SMACV2_ENV_NAMES:
    path = f"dataset/llm_{env_name}_out.jsonl"
    total_completion_tokens = 0
    total_prompt_tokens = 0
    with open(path, 'r') as f:
        for line in f:
            data = json.loads(line)["response"]["body"]["usage"]
            total_completion_tokens += data["completion_tokens"]
            total_prompt_tokens += data["prompt_tokens"]
        print(f"{env_name}\t{total_completion_tokens}\t{total_prompt_tokens}")
```

```
2c_vs_64zg      5920    2498000
5m_vs_6m        5913    1386000
6h_vs_8z        5941    1462000
corridor        5926    1772000
protoss_5_vs_5  5920    1460000
protoss_10_vs_10        5918    1660000
protoss_10_vs_11        5940    1680000
protoss_20_vs_20        5901    2060000
protoss_20_vs_23        5990    2122000
terran_5_vs_5   5990    1442000
terran_10_vs_10 5925    1642000
terran_10_vs_11 5930    1662000
terran_20_vs_20 5944    2042000
terran_20_vs_23 5977    2104000
zerg_5_vs_5     5940    1448000
zerg_10_vs_10   5914    1648000
zerg_10_vs_11   5912    1668000
zerg_20_vs_20   5942    2048000
zerg_20_vs_23   5913    2110000
```

In [618]:
```
from tensorboard.backend.event_processing.event_accumulator import EventAccumulator
```

In [619]:
```python
def read_tensorboard(logdir):
    files = os.listdir(logdir)
    path = f"{logdir}/{files[0]}"
    tb = EventAccumulator(path)
    tb.Reload()
    data = {}
    for tag in ["high", "low"]:
        for item in tb.Scalars(f"logits/{tag}"):
            if item.step not in data:
                data[item.step] = {}
            data[item.step][tag] = item.value
    max_step = max(data.keys())
    high = data[max_step]["high"]
    low = data[max_step]["low"]
    return high, low
```

In [620]:
```python
def analyze_recovered_rewards(use_llm):
    for env_name in SMACV1_ENV_NAMES + SMACV2_ENV_NAMES:
        all_highs = []
        all_lows = []
        for seed in range(4):
            path = f"logs/IPMAL/{env_name}_llm/seed{seed}" if use_llm else f"logs/IPMAL/{env_name}/seed{seed}"
            high, low = read_tensorboard(path)
            all_highs.append(high)
            all_lows.append(low)
        high_mean = np.mean(all_highs)
        high_std = np.std(all_highs)
        low_mean = np.mean(all_lows)
        low_std = np.std(all_lows)
        print(f"{env_name}\t{low_mean:.2f} ± {low_std:.2f}\t{high_mean:.2f} ± {high_std:.2f}")
```

In [621]:
```
analyze_recovered_rewards(use_llm=False)
```

```
2c_vs_64zg      −8.36 ± 0.26    9.25 ± 0.67
5m_vs_6m        −4.49 ± 0.12    4.80 ± 0.15
6h_vs_8z        −4.72 ± 0.28    5.15 ± 0.22
corridor        −12.59 ± 0.31   11.23 ± 1.06
protoss_5_vs_5  −6.31 ± 0.22    6.54 ± 0.51
protoss_10_vs_10        −7.73 ± 0.18    7.92 ± 0.32
protoss_10_vs_11        −7.95 ± 0.69    8.31 ± 0.91
protoss_20_vs_20        −8.31 ± 0.35    8.19 ± 0.16
protoss_20_vs_23        −8.01 ± 0.22    9.10 ± 0.14
terran_5_vs_5   −6.85 ± 0.30    6.93 ± 0.56
terran_10_vs_10 −8.25 ± 0.82    7.35 ± 0.61
terran_10_vs_11 −8.53 ± 0.67    9.62 ± 0.54
terran_20_vs_20 −8.59 ± 0.36    8.44 ± 0.22
terran_20_vs_23 −8.49 ± 0.65    8.91 ± 0.27
zerg_5_vs_5     −3.74 ± 0.14    3.64 ± 0.14
zerg_10_vs_10   −4.16 ± 0.16    4.27 ± 0.16
zerg_10_vs_11   −4.54 ± 0.06    4.60 ± 0.14
zerg_20_vs_20   −5.31 ± 0.08    5.25 ± 0.20
zerg_20_vs_23   −4.78 ± 0.12    5.08 ± 0.15
```

In [622]:
```
analyze_recovered_rewards(use_llm=True)
```

```
2c_vs_64zg      −12.87 ± 0.73   14.14 ± 0.80
5m_vs_6m        −4.02 ± 0.20    4.51 ± 0.18
6h_vs_8z        −5.11 ± 0.32    5.28 ± 0.16
corridor        −12.97 ± 0.33   10.93 ± 0.45
protoss_5_vs_5  −8.06 ± 0.64    7.46 ± 0.77
protoss_10_vs_10        −10.65 ± 1.15   9.32 ± 0.91
protoss_10_vs_11        −11.01 ± 0.93   10.43 ± 1.57
protoss_20_vs_20        −10.57 ± 0.86   9.54 ± 0.74
protoss_20_vs_23        −12.17 ± 0.72   12.09 ± 0.80
terran_5_vs_5   −7.85 ± 0.27    7.82 ± 0.57
terran_10_vs_10 −10.73 ± 1.49   8.16 ± 0.56
terran_10_vs_11 −9.18 ± 0.23    10.97 ± 1.38
terran_20_vs_20 −10.44 ± 0.96   10.79 ± 1.00
terran_20_vs_23 −14.90 ± 2.06   17.95 ± 2.91
zerg_5_vs_5     −5.09 ± 0.19    3.51 ± 0.06
zerg_10_vs_10   −5.93 ± 0.43    6.14 ± 0.64
zerg_10_vs_11   −7.28 ± 0.50    6.20 ± 0.50
zerg_20_vs_20   −7.71 ± 0.54    7.24 ± 0.23
zerg_20_vs_23   −8.26 ± 1.13    8.00 ± 0.43
```