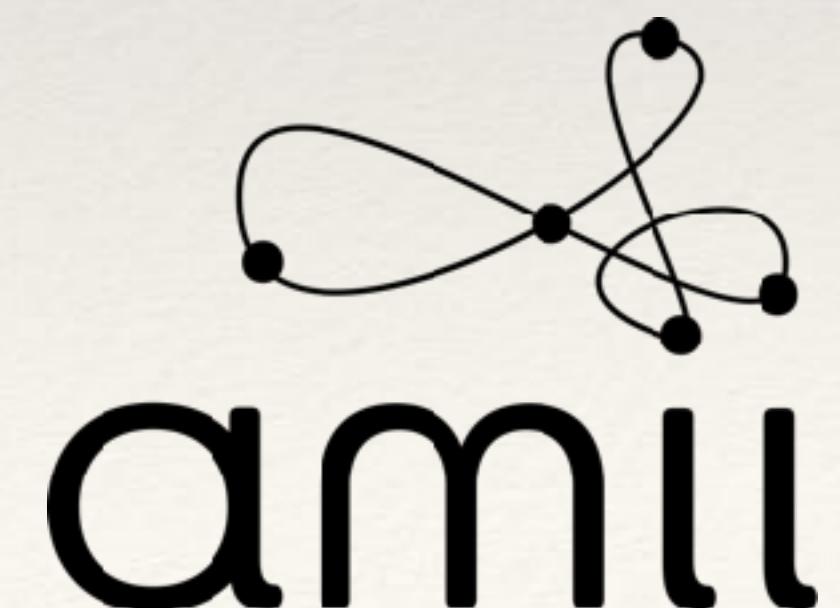


# What can we Learn Even From the Weakest? Learning Sketches for Programmatic Strategies

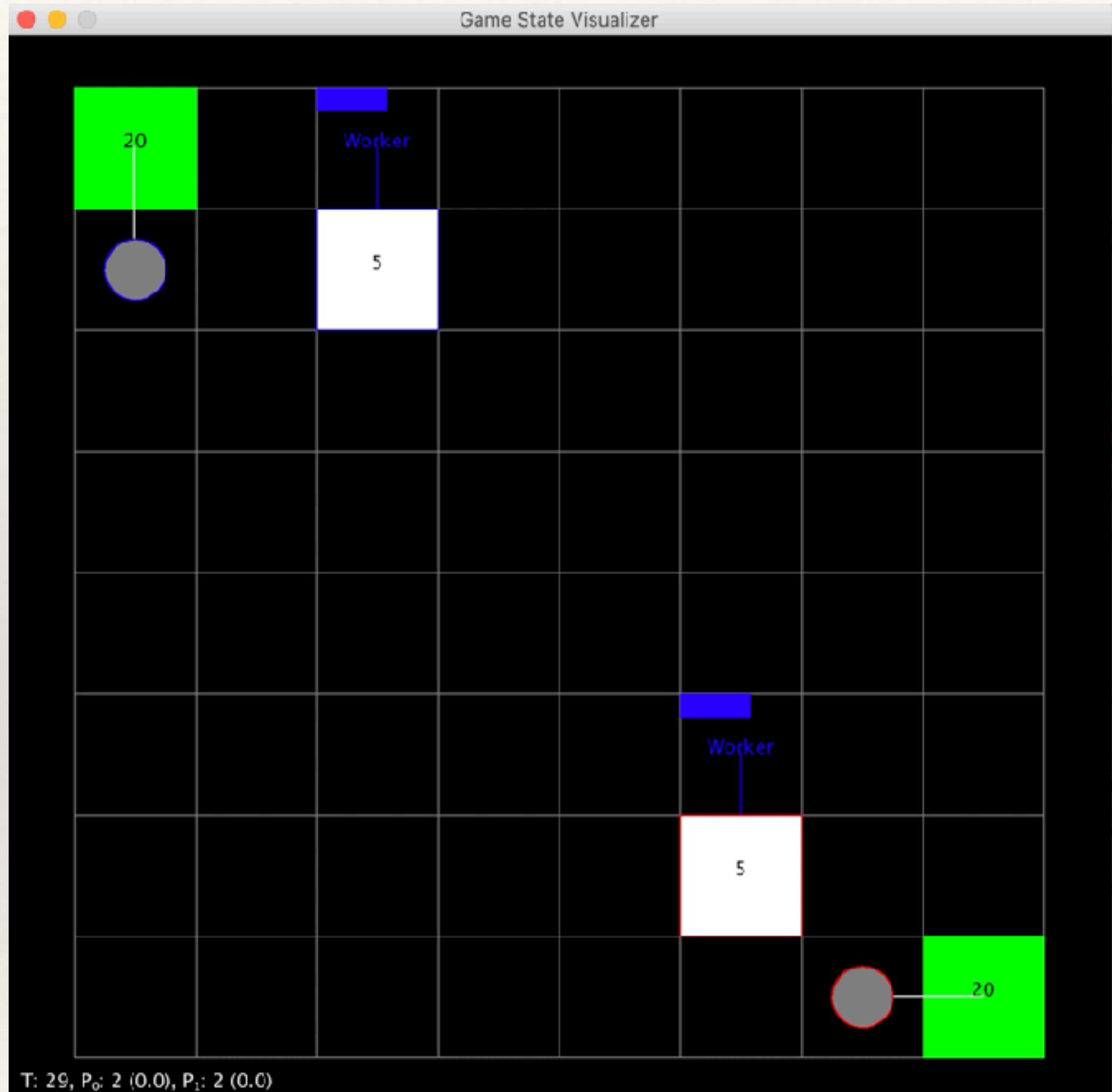
*Leandro Couto, David Aleixo, and Levi H. S. Lelis*

*University of Alberta, Amii, Canada*

*Universidade Federal de Viçosa, Brazil*



# Programmatic Strategies

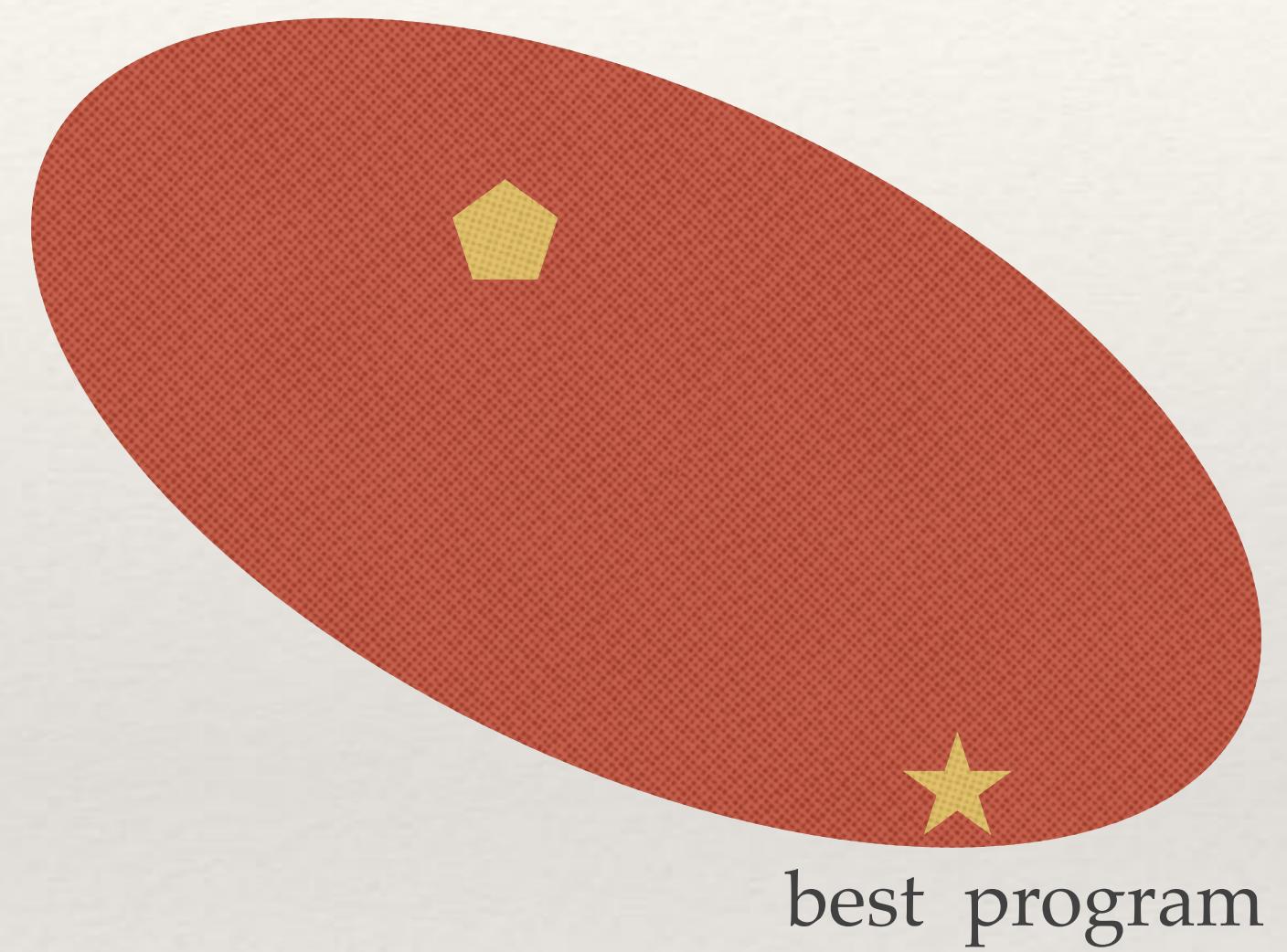


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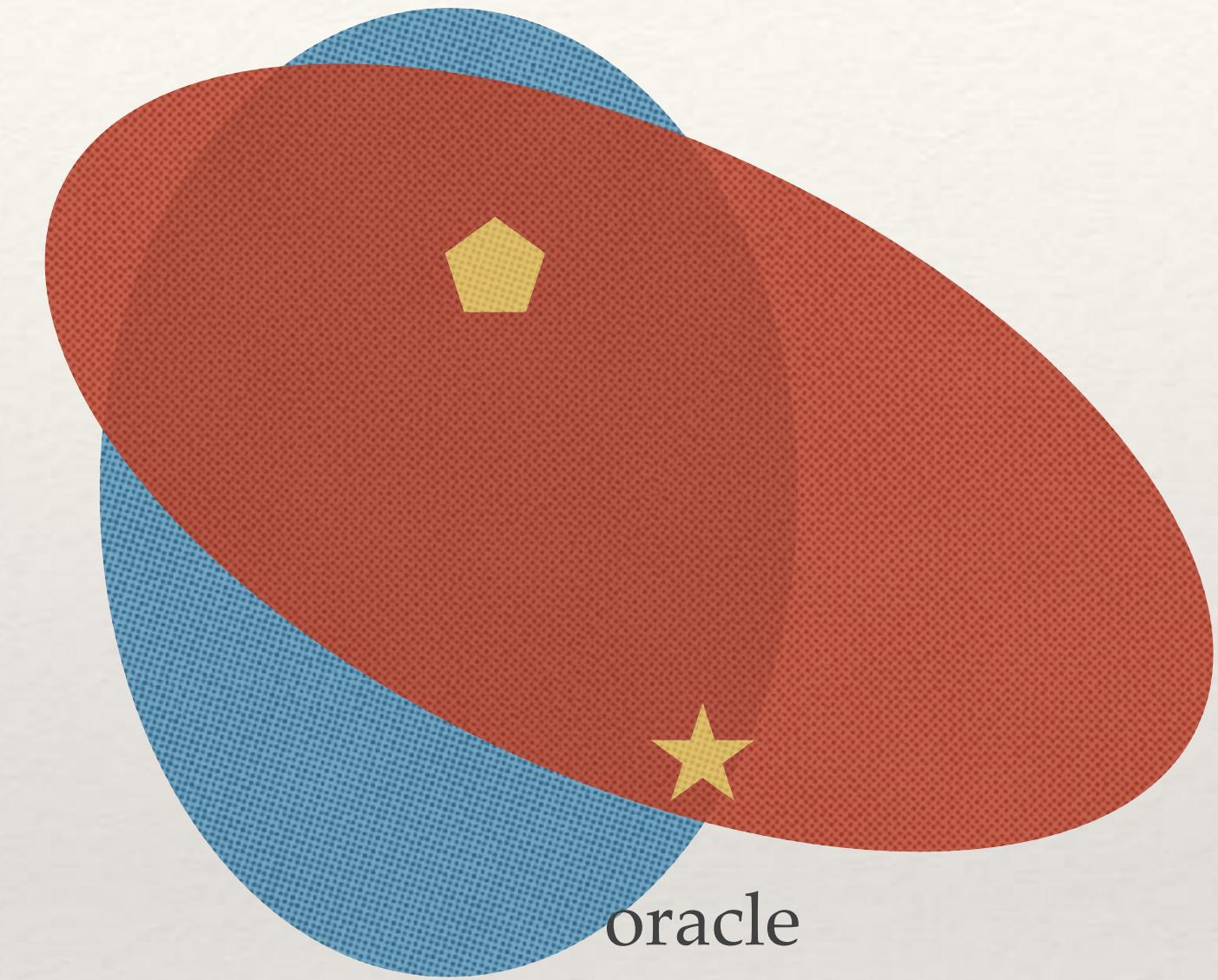
```
1 train(Worker)
2 for(each unit u)
3   if(IsDistantFromEnemy(u, 4)
4     attack(u, closest)
5   harvest(u)
6   attack(u, closest)
```

---

# Direct Synthesis

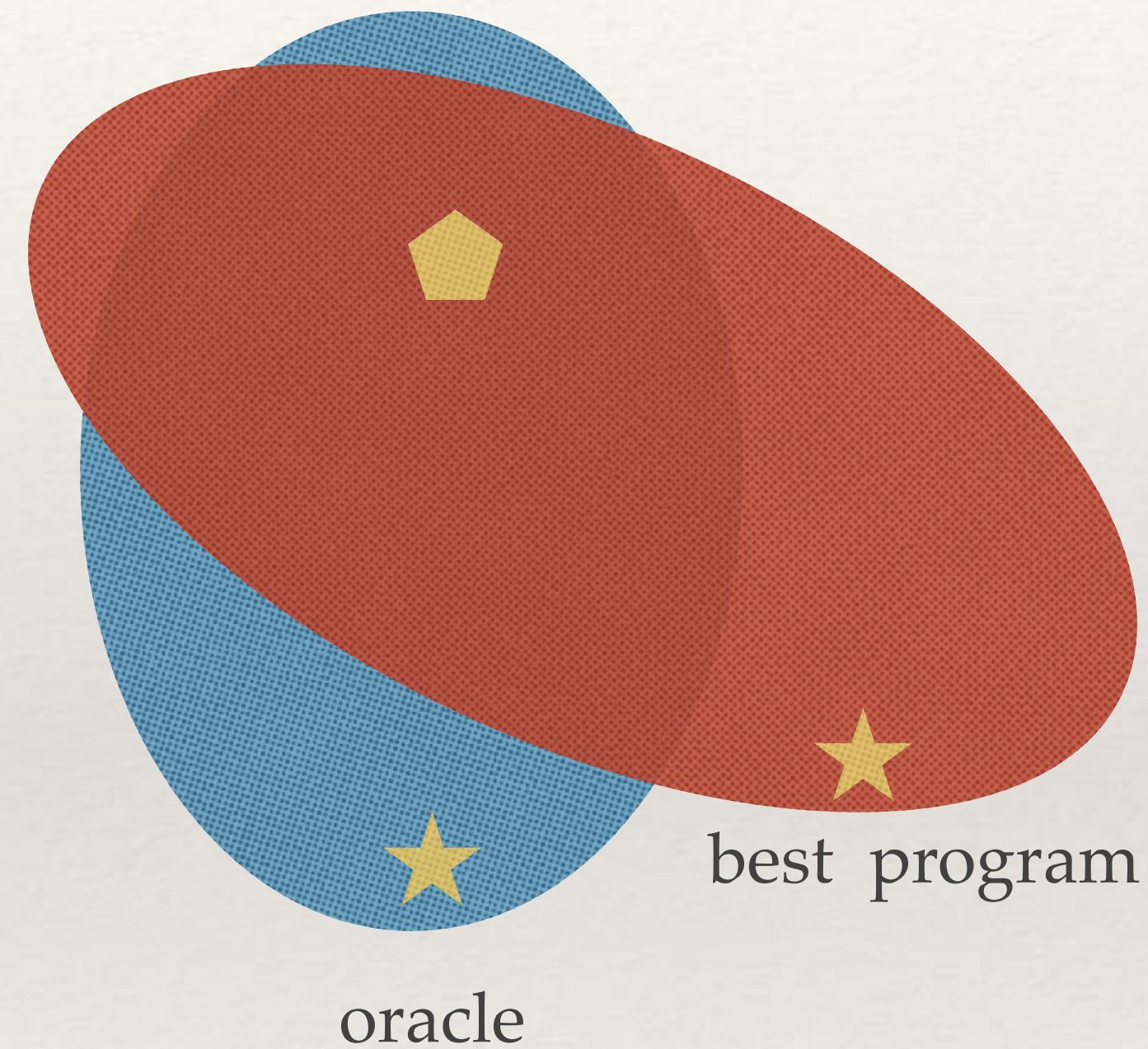


# Imitation Learning



(Bastani et al. 2018) (Verma et al. 2018, 2019)

# Representation Gap

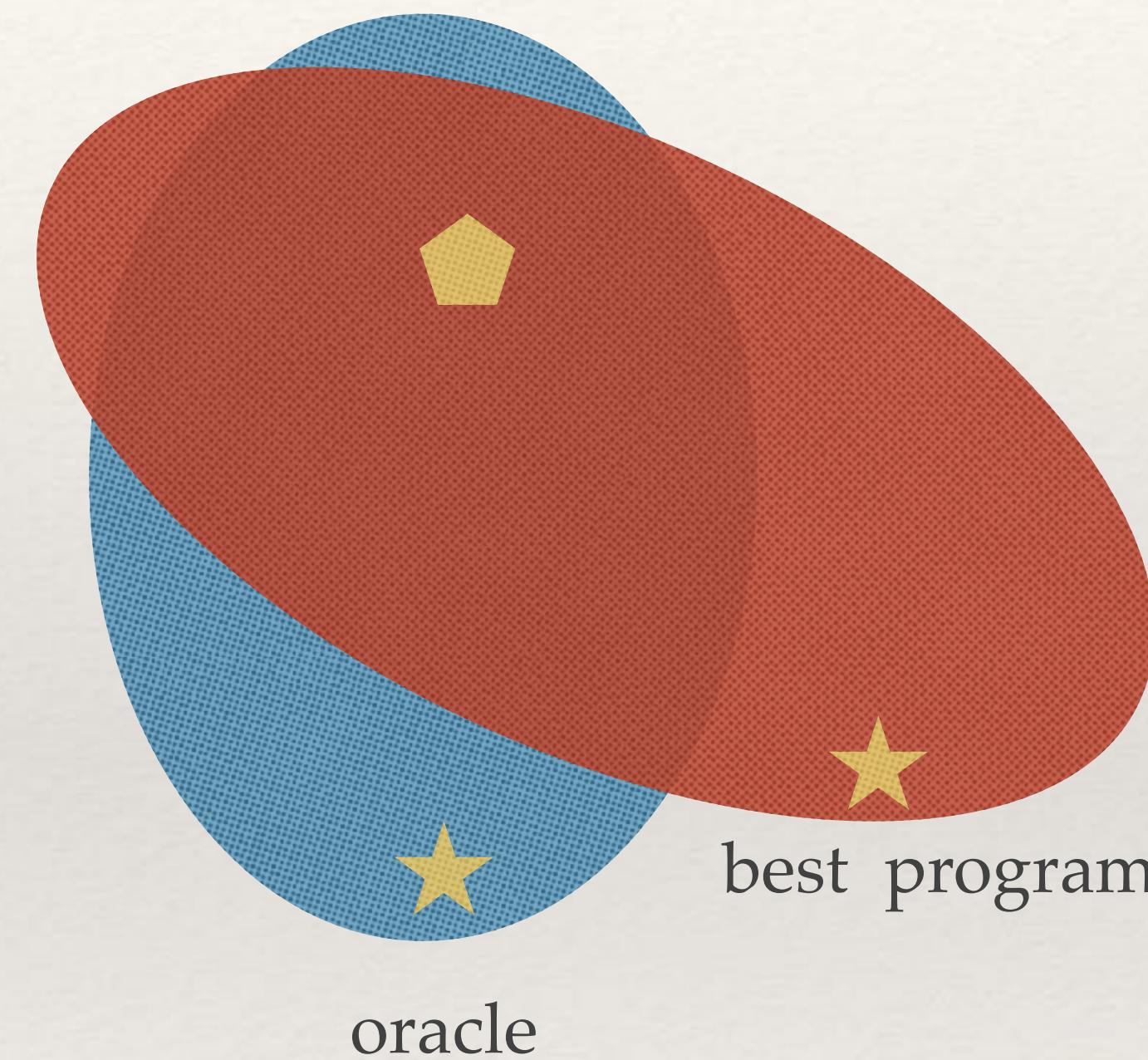


# Learning Sketches

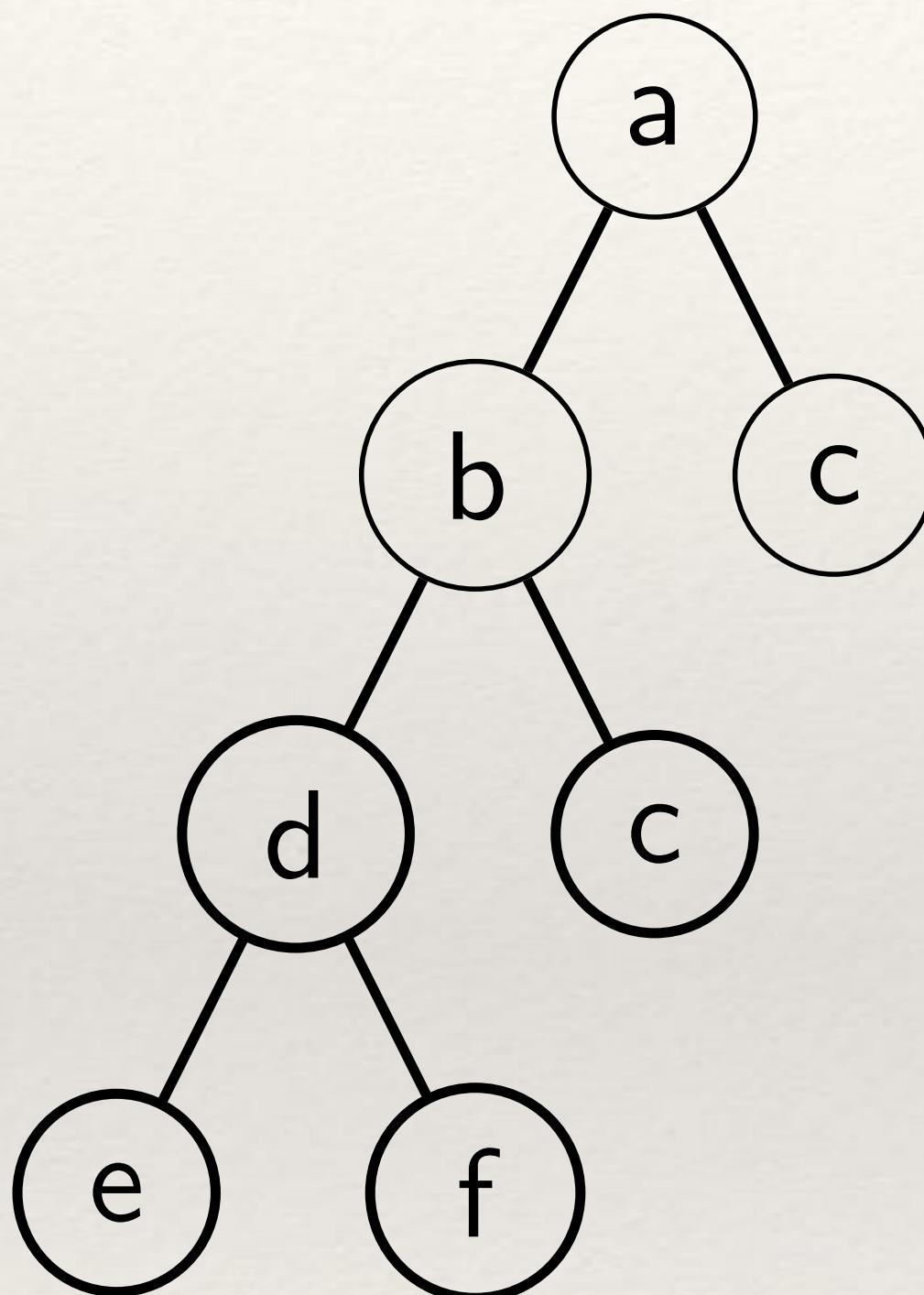
---

```
1 def get_action(self, state):
2     actions = state.available_moves()
3     if actions == ['y', 'n']:
4         score = sum(map(lambda x: (f1+1)*l4, l2)) + f5
5         if win_after_n(state):
6             return 'n'
7         elif available_columns(state):
8             return 'y'
9         else:
10            if score >= 29:
11                return 'n'
12            else:
13                return 'y'
14     else:
15         index = argmax(map(lambda x: sum(map(lambda x: f2 *
16                                         5 - 6 * f6, l1)), l3))
16         return actions[index]
```

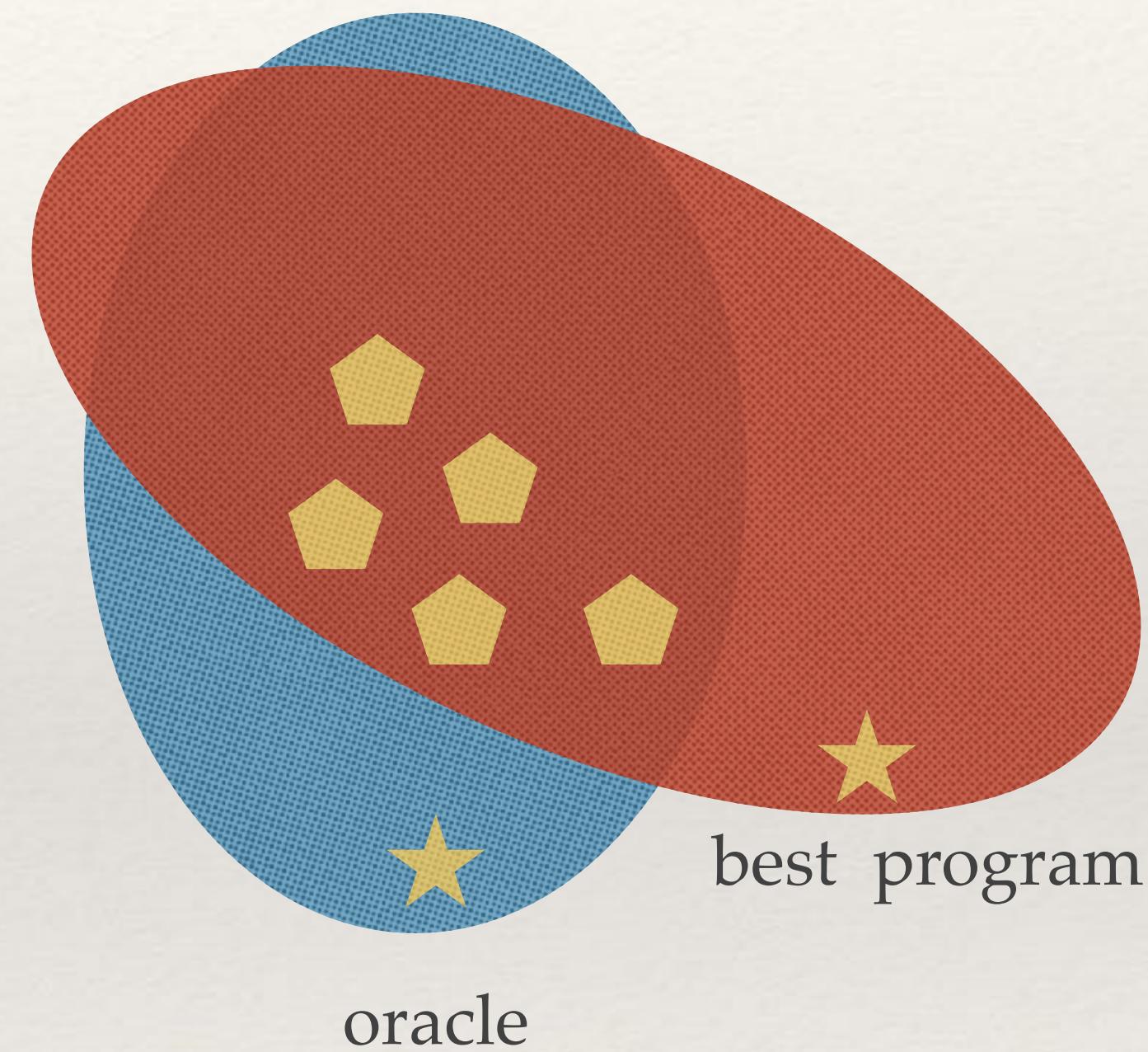
# Learning Sketches with Local Search



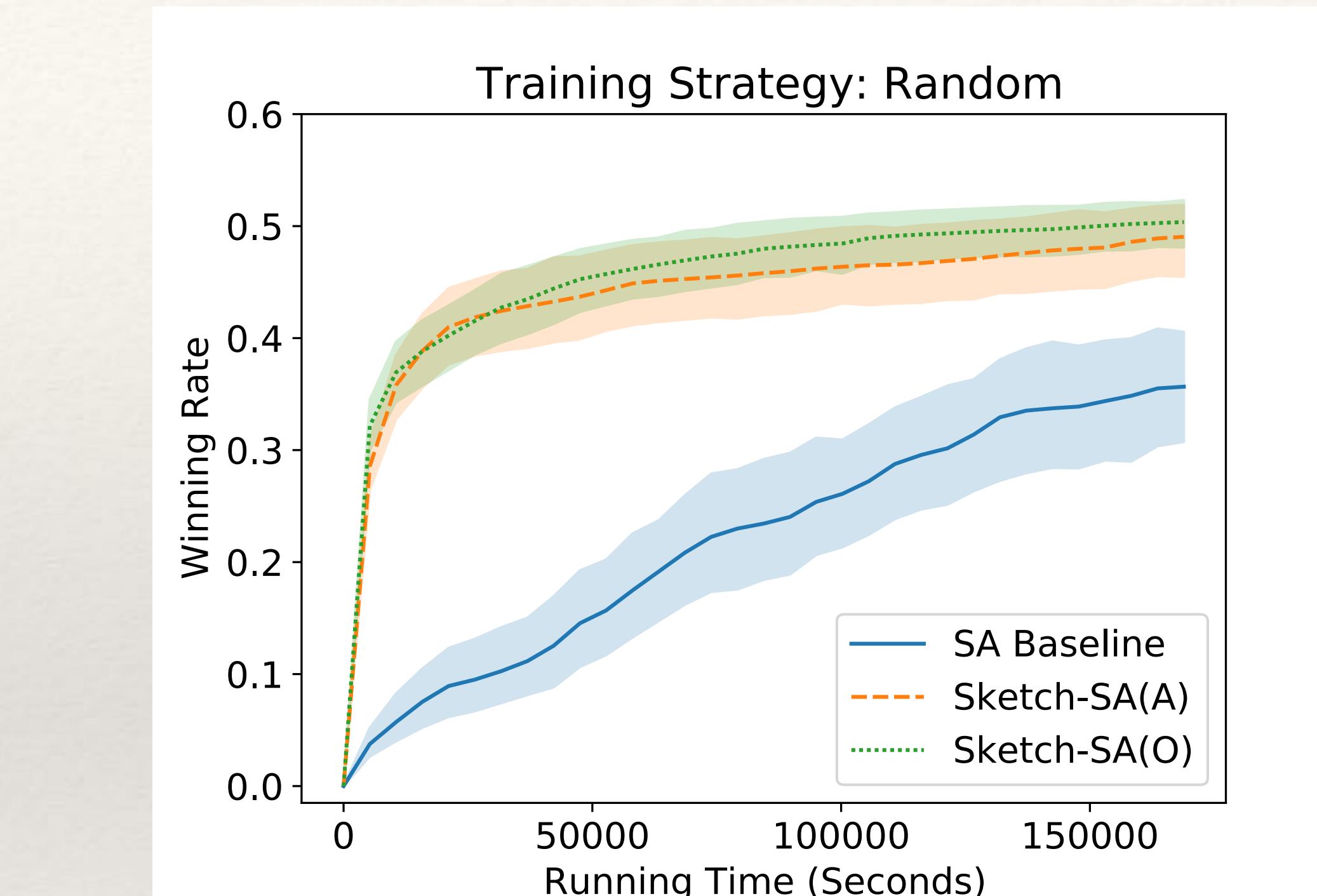
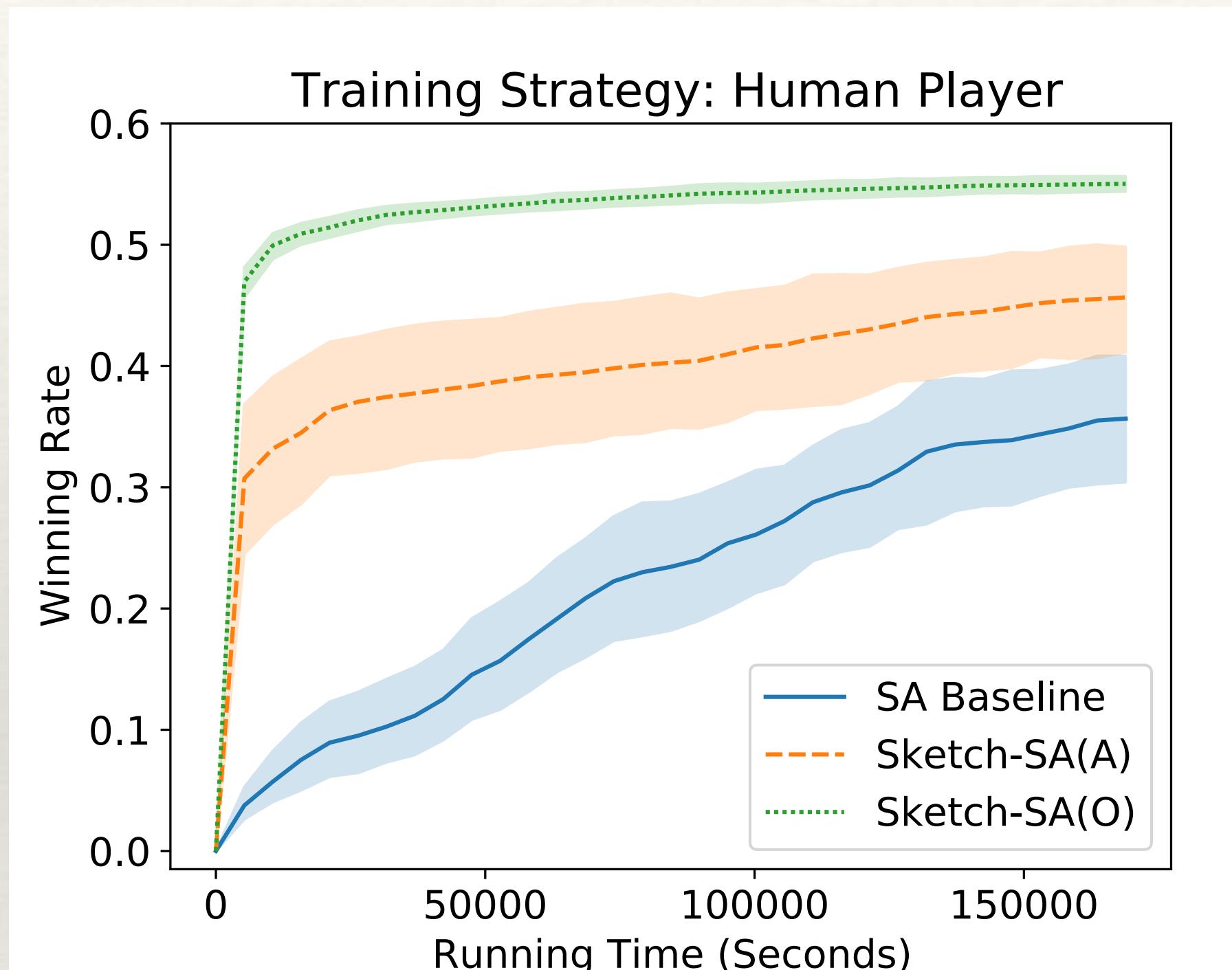
# Learning Sketches with MCTS



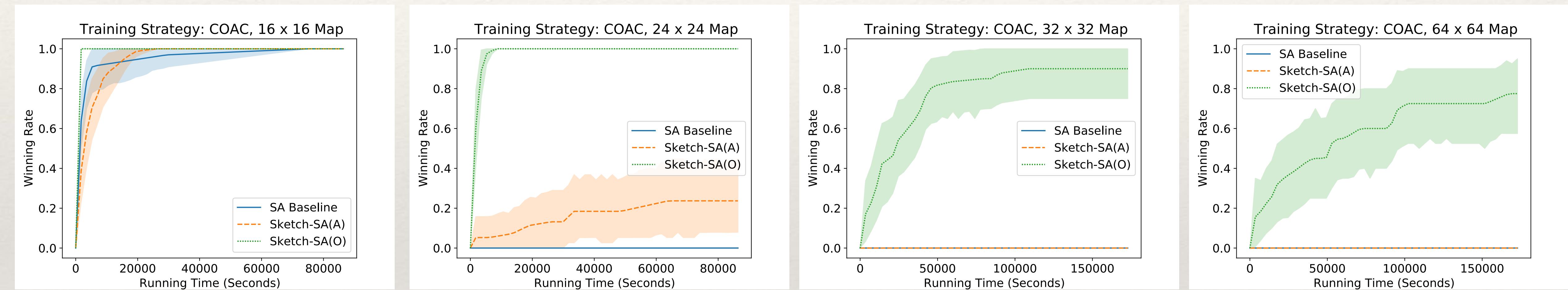
a, b, c represents **argmax**(**map**(**lambda** x: ?))



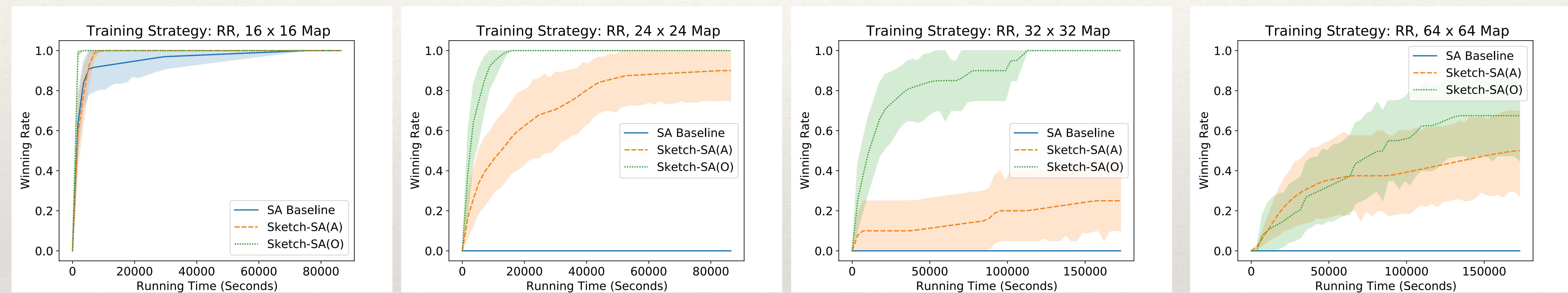
# Can't Stop



# MicroRTS



# MicroRTS



# Conclusions

- ❖ **No representation gap:** even when imitating very weak strategies we were able to synthesize strong ones.
- ❖ **Small data:** used only 3 matches.
- ❖ **No oracle around:** no need to Dagger-like procedures.

# Acknowledgements

- ❖ Canada's AI CIFAR Chair and NSERC
- ❖ Brazil's Capes and FAPEMIG

# Example MicroRTS

---

```
1 def Sketch-SA-0-24x24(state s):
2     for u in s:
3         if not u.isWorker():
4             u.moveToUnit(Ally, LessHealthy)
5             u.train(Ranged)
6             for u in s:
7                 u.attackIfInRange()
8                 u.build(Barracks)
9             for u in s:
10                u.harvest(4)
11                u.attack(LessHealthy)
```

---