

The Advantage of Doubling:

A Deep Reinforcement Learning Approach to Studying the Double Team in the NBA

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Motivation

“Do you double and risk giving up easy shots, or stay at home and do the best you can?” - Brad Stevens 2017

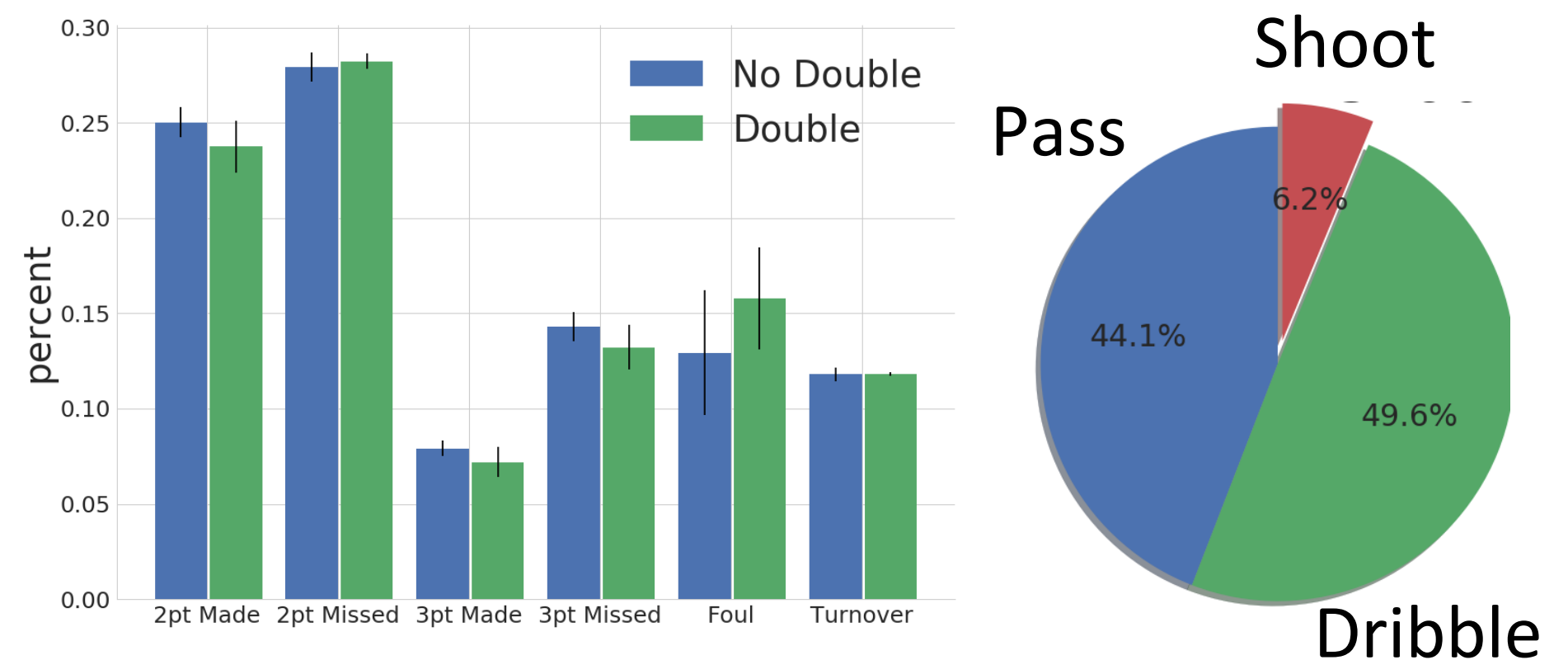
Analysis Pipeline

- Label possessions as “Double Team” or not
- Analyze outcomes associated with doubling
- Learn “optimal” strategy with Double Dueling DQN¹

Data

NBA player tracking data, 3 seasons (‘14-‘15 — ‘16-‘17)
Total # of possessions considered: 643,147

Observational Analysis



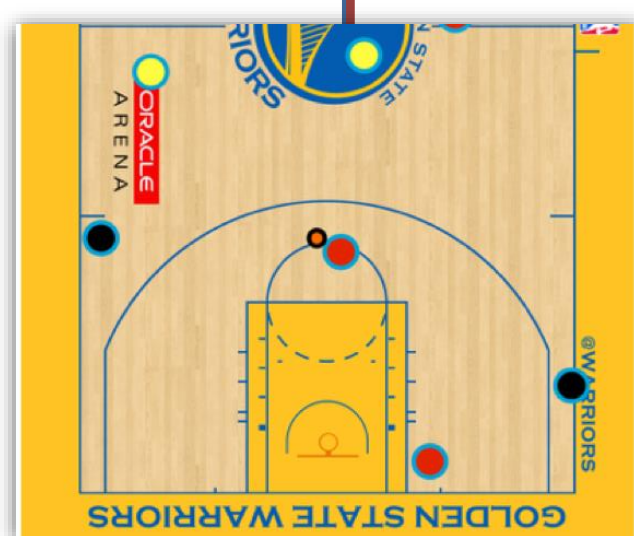
Reinforcement Learning Framework

S : state (e.g., court configuration, clocks, player info)



Agent - defense

\mathcal{R} : reward (e.g., -ppp)



Environment

a : action (e.g., double, leaving open man on left wing)

Decision Frequency - 1 Hz

$\pi(a|s) := P(a|s)$ Policy - probabilistic mapping of state to action

Goal: learn a policy that maximizes the expected value of the cumulative discounted reward

$$G_t := \sum_{t=t_0}^T \gamma^{t-t_0} r_t$$

Expected cumulative reward of starting in state s , taking action a , and then following optimal policy

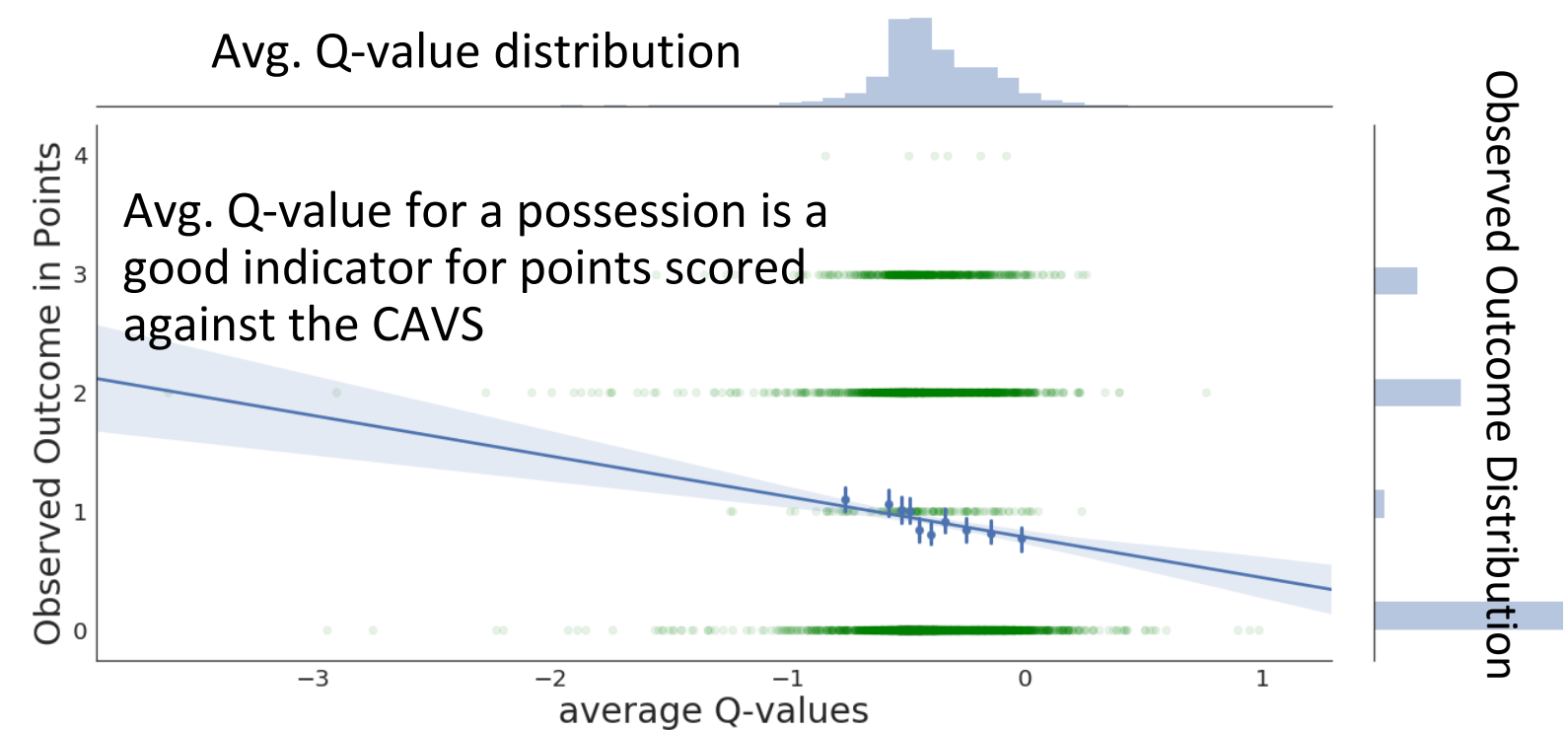
$$Q^{\pi^*}(s, a) = \max_{\pi} \mathbb{E}_{a_{t+1}:T-1 \sim \pi} [G_t | s_t = s, a_t = a]$$

Optimal state value

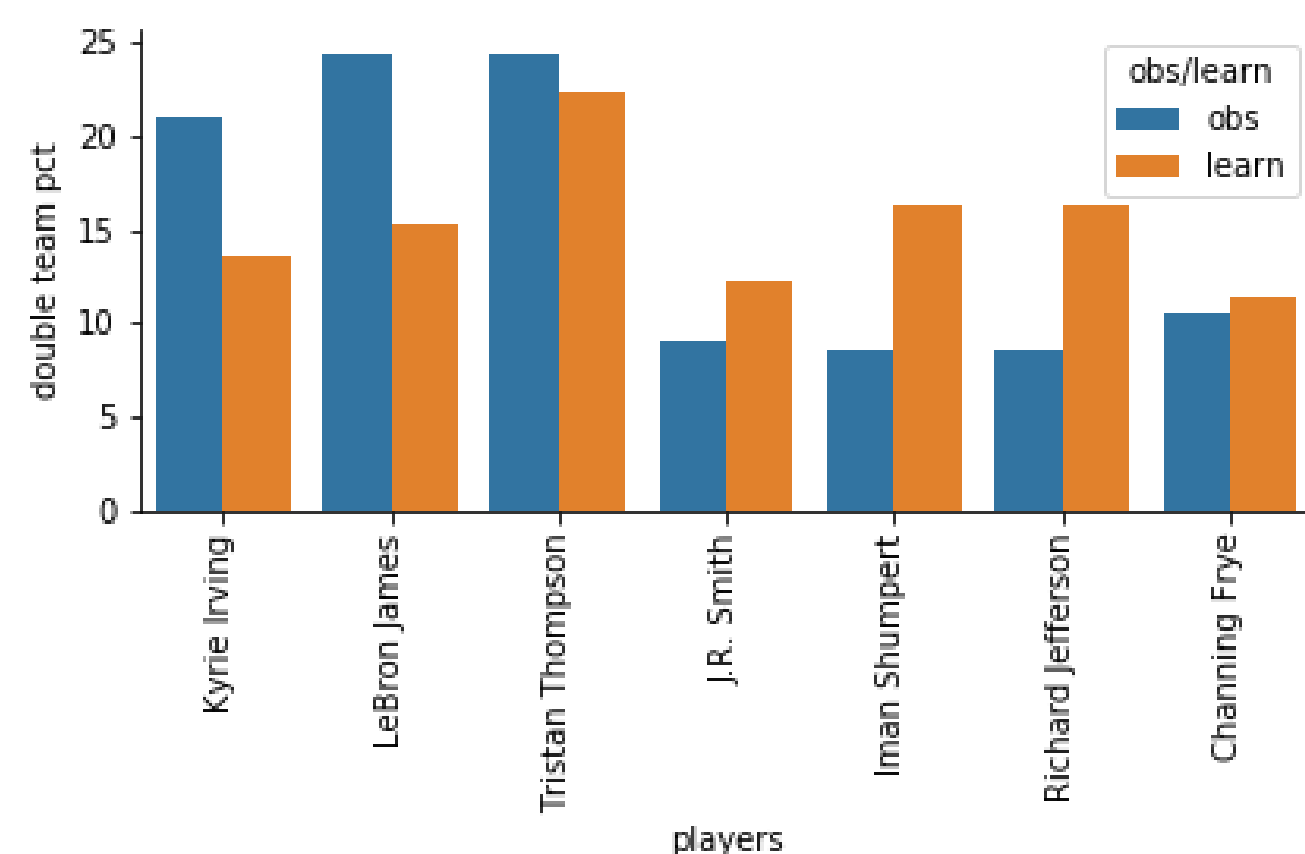
$$V^{\pi^*}(s_{t+1}) = \max_{a \in \mathcal{A}_{t+1}} Q^{\pi^*}(s_{t+1}, a)$$

$$\mathcal{L} = \sum_{i=1}^N \sum_{t=1}^{T_i-1} (Q^{\pi^*}(s_t^i, a_t^i) - (r_t^i + V^{\pi^*}(s_{t+1}^i)))^2$$

Learn Q-values by minimizing temporal difference across N possessions

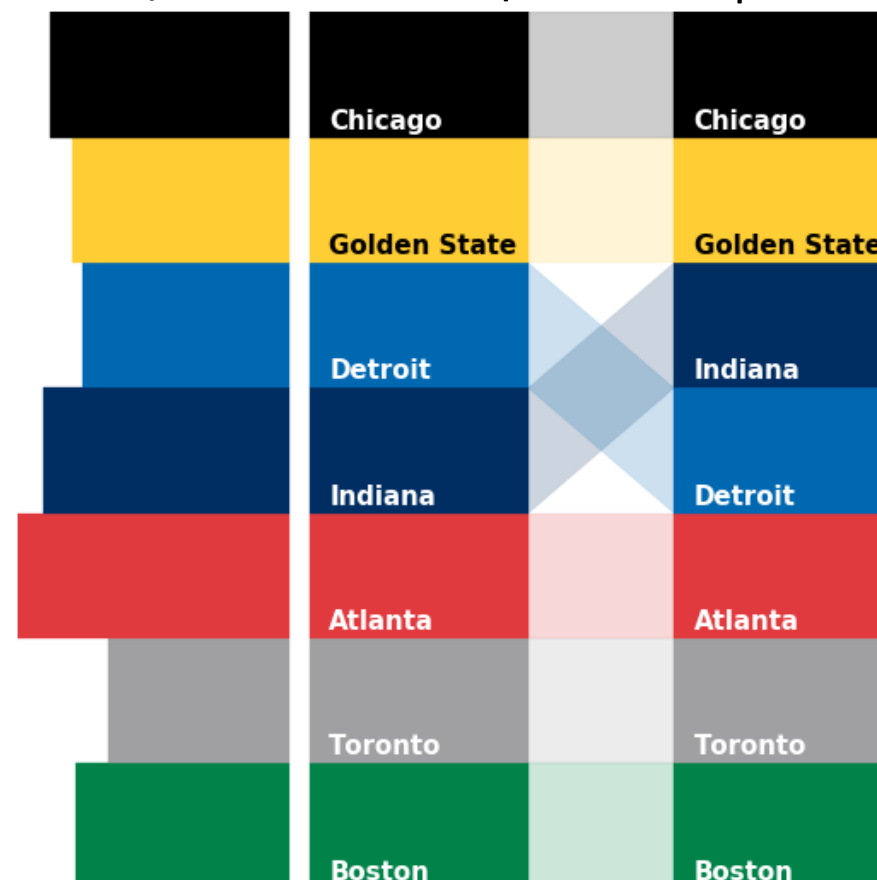


Results

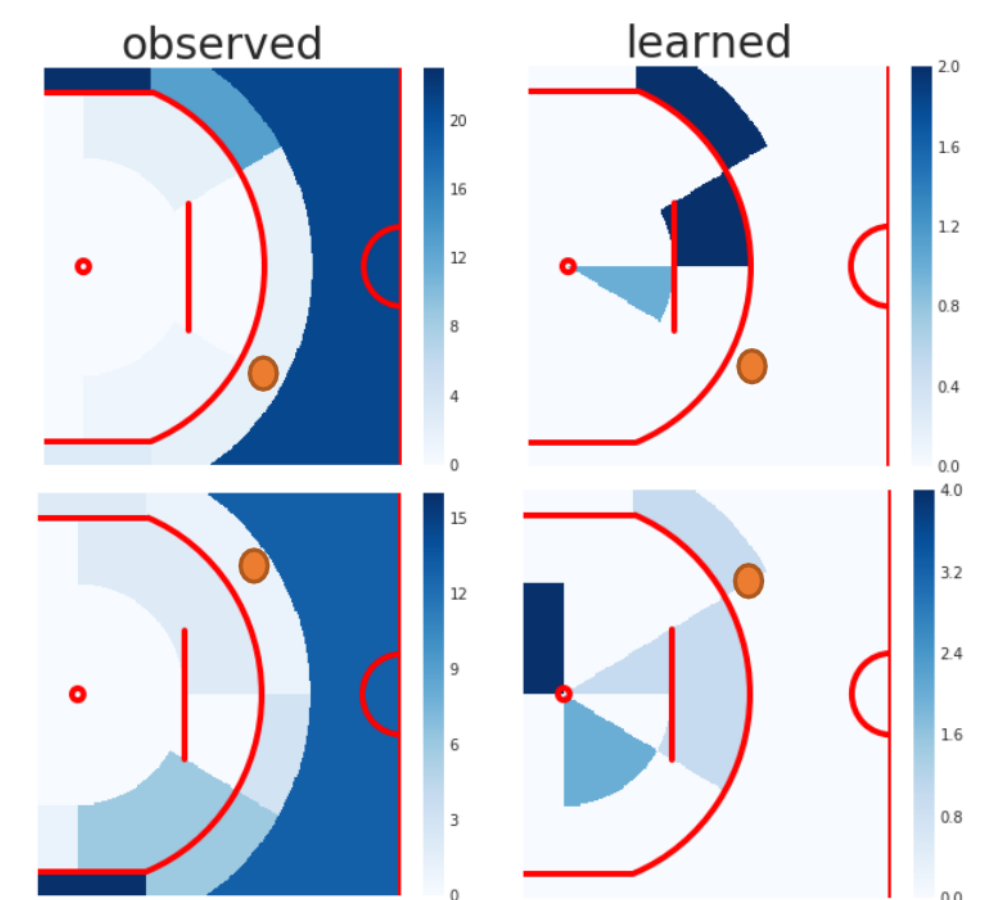


Learned policy recommends double teaming role players more often than star players

Room to improve Current perf. Improved perf.



All teams could improve in double teaming, where room for improvement is $V^{\pi^*}(s) - Q^{\pi^*}(s, a)$ aggregated for each teams' states and actions



Learned policy produces an asymmetric pattern for where to leave the open man when doubling Kyrie Irving from the left/right of the 3 point line