

## On-policy first-visit MC control (for $\varepsilon$ -soft policies), estimates $\pi \approx \pi_*$

Algorithm parameter: small  $\varepsilon > 0$

Initialize:

$\pi \leftarrow$  an arbitrary  $\varepsilon$ -soft policy

$Q(s, a) \in \mathbb{R}$  (arbitrarily), for all  $s \in \mathcal{S}$ ,  $a \in \mathcal{A}(s)$

$Returns(s, a) \leftarrow$  empty list, for all  $s \in \mathcal{S}$ ,  $a \in \mathcal{A}(s)$

Repeat forever (for each episode):

Generate an episode following  $\pi$ :  $S_0, A_0, R_1, \dots, S_{T-1}, A_{T-1}, R_T$

$G \leftarrow 0$

Loop for each step of episode,  $t = T-1, T-2, \dots, 0$ :

$G \leftarrow \gamma G + R_{t+1}$

Unless the pair  $S_t, A_t$  appears in  $S_0, A_0, S_1, A_1, \dots, S_{t-1}, A_{t-1}$ :

Append  $G$  to  $Returns(S_t, A_t)$

$Q(S_t, A_t) \leftarrow \text{average}(Returns(S_t, A_t))$

$A^* \leftarrow \arg\max_a Q(S_t, a)$  (with ties broken arbitrarily)

For all  $a \in \mathcal{A}(S_t)$ :

$$\pi(a|S_t) \leftarrow \begin{cases} 1 - \varepsilon + \varepsilon/|\mathcal{A}(S_t)| & \text{if } a = A^* \\ \varepsilon/|\mathcal{A}(S_t)| & \text{if } a \neq A^* \end{cases}$$