

# Average Reward Value Function

(no exam)

- The value function of an undiscounted, ergodic MDP can be expressed in terms of average reward.
- $\tilde{v}_\pi(s)$  is the extra reward due to starting from state  $s$ ,

$$\tilde{v}_\pi(s) = \mathbb{E}_\pi \left[ \sum_{k=1}^{\infty} (R_{t+k} - \rho^\pi) \mid S_t = s \right]$$

There is a corresponding average reward Bellman equation,

$$\begin{aligned} \tilde{v}_\pi(s) &= \mathbb{E}_\pi \left[ (R_{t+1} - \rho^\pi) + \sum_{k=1}^{\infty} (R_{t+k+1} - \rho^\pi) \mid S_t = s \right] \\ &= \mathbb{E}_\pi [(R_{t+1} - \rho^\pi) + \tilde{v}_\pi(S_{t+1}) \mid S_t = s] \end{aligned}$$