

$$\begin{aligned}
v_{\pi}(s) &= \mathbb{E}_{\pi} [G_t \mid S_t = s] = \\
&= \mathbb{E}_{\pi} [R_{t+1} + \gamma G_{t+1} \mid S_t = s] = \\
&= \mathbb{E}_{\pi} [R_{t+1} \mid S_t = s] + \gamma \mathbb{E}_{\pi} [G_{t+1} \mid S_t = s] = \\
&= \sum_{r \in \mathcal{R}} r \mathbb{P} (R_{t+1} = r \mid S_t = s) + \gamma \mathbb{E}_{\pi} [G_{t+1} \mid S_t = s]
\end{aligned} \tag{1}$$