$$V^\pi(s) = \mathbb{E}_\pi\left[\sum_{t=1}^{\infty} \gamma^{t-1} r_t \,\middle|\, s_1 = s\right]$$

s, a, r, s'

$V^\pi(s) \longleftrightarrow V^\pi(s')$

$$= \mathbb{E}_\pi\left[r_1 + \sum_{t=2}^{\infty} \gamma^{t-1} r_t \,\middle|\, s_1 = s\right]$$

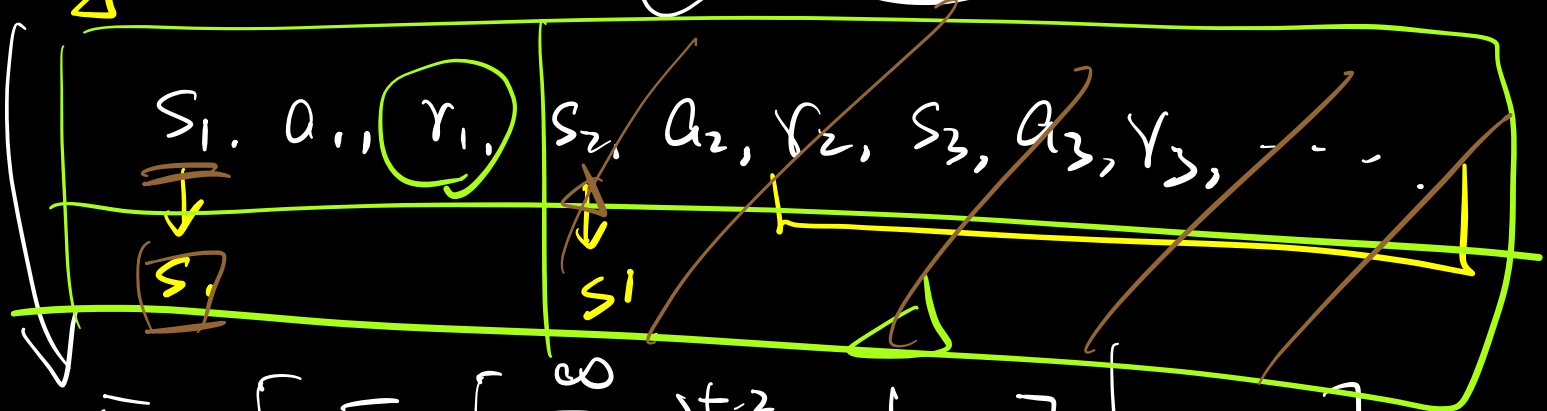
$$= \mathbb{E}_\pi[r_1 \mid s_1 = s] + \mathbb{E}_\pi\left[\sum_{t=2}^{\infty} \gamma^{t-1} r_t \,\middle|\, s_1 = s\right]$$

deterministic.

$\pi : S \to A$.

$$= R(s, \pi(s)) + \gamma\, \mathbb{E}_\pi\left[\sum_{t=2}^{\infty} \gamma^{t-2} r_t \,\middle|\, s_1 = s\right]$$

$$\mathbb{E}_\pi\left[\mathbb{E}_\pi\left[\sum_{t=2}^{\infty} \gamma^{t-2} r_t \,\middle|\, s_1 = s, s_2\right] \,\middle|\, s_1 = s\right]$$



$$\mathbb{E}_\pi\left[\mathbb{E}_\pi\left[\sum_{t=2}^{\infty} \gamma^{t-2} r_t \,\middle|\, s_2\right] \,\middle|\, s_1 = s\right]$$

$$\mathbb{E}_\pi\left[V^\pi(s_2) \,\middle|\, s_1 = s\right]$$

$s_2 \sim P(\cdot \mid s, \pi(s))$.

$\mathbb{E}_{s' \sim P(\cdot \mid s, \pi(s))}[V^{\pi}(s')]$.