

Assignment 12, Problem 3:

$$\sum_{u=t}^{T-1} \gamma^{u-t} (R_{u+1} + \gamma V(s_{u+1}) - V(s_u))$$

$$= \sum_{u=t}^{T-1} \gamma^{u-t} R_{u+1} + \underbrace{\sum_{u=t}^{T-1} \gamma^{u-t+1} V(s_{u+1})}_{\text{Substitute } u' = u+1} - \sum_{u=t}^{T-1} \gamma^{u-t} V(s_u)$$

$$\underbrace{\sum_{u'=t+1}^T \gamma^{u'-t} V(s_{u'})}_{\text{Combine overlapping terms}} - \sum_{u=t}^{T-1} \gamma^{u-t} V(s_u)$$
$$\gamma^{T-t} V(s_T) - V(s_t)$$

$$= \underbrace{\sum_{u=t}^{T-1} \gamma^{u-t} R_{u+1} + \gamma^{T-t} V(s_T) - V(s_t)}_{\substack{\text{Substitute definition of Return} \\ G_t}}$$

$$= G_t - V(s_t)$$

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