Z-learning in problems of energy systems

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Goal of research

Goal

To compare results of working of Z-learning and Q-learning in problem of energy systems.

Problem

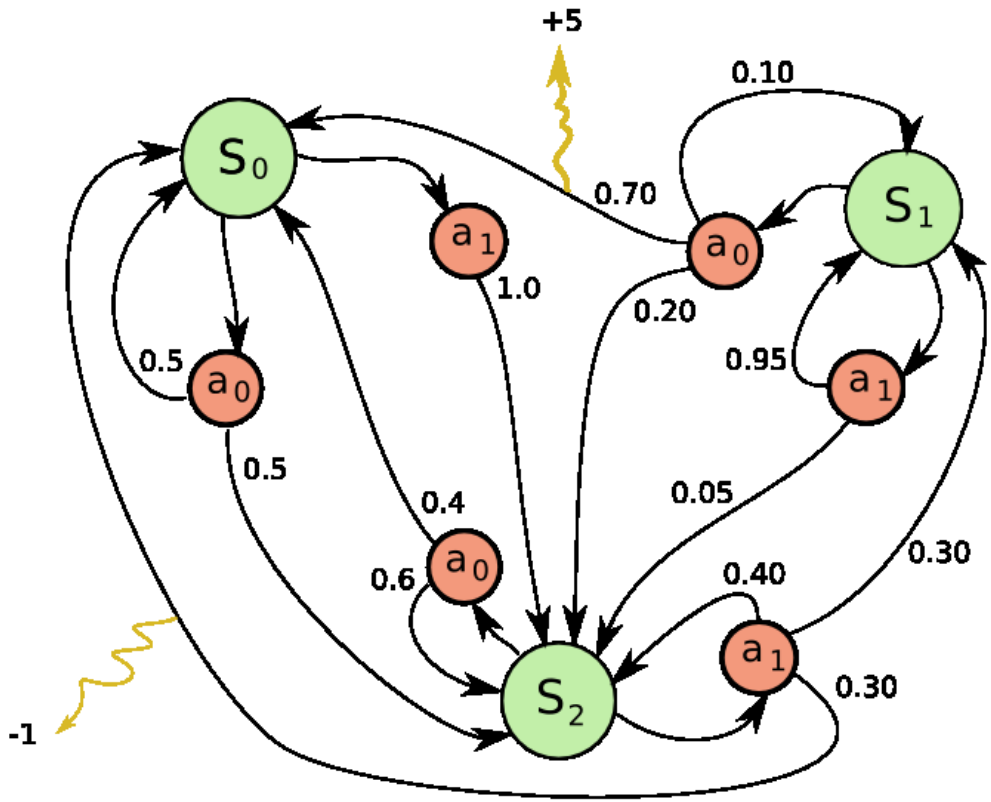
Transfer the system of device from one statement to another optimizing the energy spent

Method

A modification of the classical Q-learning method is used.

Statement - Energy

$$(S, A, P, R)$$



Picture from https://ru.wikipedia.org

Statement - Energy

$$\min_{p,\rho} \sum_{t=0}^{T-1} \sum_{j} \rho_j(t) \left(\sum_{i} p_{ij}(t) \left(U_i(t+1) + \gamma_{ij} \log \frac{p_{ij}}{\bar{p}_{ij}} \right) \right) \quad (1)$$

$$\text{s.t.} \sum_{i} p_{ij}(t) = 1, \quad \forall t, \quad \forall j \quad (2)$$

$$\rho_i(t+1) = \sum_{j} p_{ij}(t)\rho_j(t) = 1, \quad \forall t, \quad \forall i \quad (3)$$

$$\text{initial conditions: } \rho_i(0), \quad \forall i \quad (4)$$

Basic code

Algorithm 1 Z - learning

1: **Initialize:** Z
2: **Input:** $\mathfrak{G} = (i_k, j_k, u_k)$
3: **for** $t = 0, 1, 2, \ldots, k-1$
4: $\quad Z(s_k) := (1 - \alpha_t) Z(i_k) + \alpha_k \exp(-u_k) Z(j_k)$
5: **return** Z

Algorithm 3 Q - learning

1: **Initialize:** Q
2: **Input:** $\mathfrak{G} = (i_k, j_k, u_k)$
3: **for** $t = 0, 1, 2, \ldots, k-1$
4: $\quad Q(i_k, p_k) := (1 - \alpha_k) Q(i_k, p_k) + \alpha_k \min\limits_{p'} (l_k + Q(j_k, p'))$
5: **return** Q

Results