0.1 Capacity expansion

1. **States**(S_t)
   (a) Number of generators i in region r $(n_{i,r,t})$ [Physical state]
   (b) Binary decision to denote transmission line built$l$ $(nt_{l,t})$ [Physical state]
   (c) Demand for power in region r [Belief state] $(Dem_{r,t})$
2. **Other known information**
   (a) Capacity of generator Cap_i^{gen} and transmission line Cap_l^{trans}
   (b) Installation cost of generators $C_i^{inst,gen}$ and transmission lines $C_l^{inst,trans}$
   (c) Maximum generators in a region $maxgen_{i,r}$
3. **Actions** (A_t)
   (a) number of generators i added in region$r(n_{i,r,t}^{add})$
   (b) Power flow in transmission line l $(P_{l,t})$ (l defined as a tuple in one way)
4. **Action Correction Functions**
   (a) **Santize actions**: If power flow $P_{l,t}^l$ is negligible (between $-\epsilon, \epsilon$), it converts it to 0. It also rounds the actions $n_{i,r,t}^{add}$ to the nearest integer
   (b) **Check bounds cost**:
   - if $n_{i,r,t}^{add} < 0$, then $cost_t + = P + D.(n_{i,r,t}^{add})^2$ and $n_{i,r,t}^{add} = 0$ for all generators, in all regions, in all times
   - if $n_{i,r,t}^{add} + n_{i,r,t-1} > maxgen_{i,r}$, then $cost_t + = P + D.(n_{i,r,t}^{add} + n_{i,r,t-1} - maxgen_{i,r})^2$ and $n_{i,r,t}^{add} = 0$ for all generators, in all regions, in all times
   - if $P_{l,t} < -Cap_{l,t}^{trans}$, then $cost_t + = P$ and $P_{l,t} = -Cap_{l,t}^{trans}$
   - if $P_{l,t} > Cap_{l,t}^{trans}$, then $cost_t + = P$ and $P_{l,t} = Cap_{l,t}^{trans}$
5. **Transition function**
   (a) Change the number of generators
   - $n_{i,r,t} = n_{i,r,t-1} + n_{i,r,t}^{add} \quad \forall i, r, t >= 1$
   - $reward_t + = -\sum_i \sum_r n_{i,r,t}^{add} C_i^{inst,gen} \quad \forall t \geq 1$

   (b) Change in transmission network
   - $nt_{l,t} = 1 \quad \forall l, t >= 1, P_{l,t} \neq 0, nt_{l,t-1} = 0$
   - $reward_t + = -\sum_{l|nt_{l,t-1}=0, nt_{l,t}=1} C_l^{inst,trans} \quad \forall t \geq 1$

   (c) Demand Satisfaction

- $P_{(r_1,r_2)} = -P_{(r_1,r_2)}$. We define the transmission lines going only in one way that is either (r_1, r_2) or (r_2, r_1) and not both
- $avail_{r,t} = \sum_i Cap_i^{gen} n_{i,r,t} + \sum_{r' | (r',r) \in L} P_{(r',r),t} \quad \forall t \geq 1$
- if $avail_{r,t} < 0, cost_t + = D.(avail)^2 \quad \forall r, t \geq 1$
- if $avail_{r,t} < Dem_{r,t}, cost_t + = P + D.(Dem_{r,t} - avail_{r,t})^2 \quad \forall r, t \geq 1$