

## 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) Retirement cost of generator  $C_i^{ret,gen}$

### 3. Actions ( $A_t$ )

- (a) number of generators  $i$  added in region  $r$  ( $n_{i,r,t}^{add}$ )
- (b) number of generators  $i$  retired in region  $r$  ( $n_{i,r,t}^{ret}$ )
- (c) 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  $n_{i,r,t}^{add}$  and  $n_{i,r,t}^{ret}$  to the nearest integer
- (b) **Check bounds cost:**
  - if  $n_{i,r,t}^{add} < 0$ , then  $cost_t += P + (n_{i,r,t}^{add})^2$  and  $n_{i,r,t}^{add} = 0$  for all generators, in all regions, in all times
  - if  $n_{i,r,t}^{ret} < 0$ , then  $cost_t += P + (n_{i,r,t}^{ret})^2$  and  $n_{i,r,t}^{ret} = 0$  for all generators, in all regions, in all times
  - if  $n_{i,r,t}^{ret} > n_{i,r,t}$ , then  $cost_t += P + (n_{i,r,t}^{ret} - n_{i,r,t})^2$  and  $n_{i,r,t}^{ret} = n_{i,r,t}$  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
  - $n_{i,r,t} = n_{i,r,t-1} + n_{i,r,t}^{add} - n_{i,r,t}^{ret} \quad \forall i, r, t \geq 1$
  - $reward_t += \sum_i \sum_r (-n_{i,r,t}^{add} C_i^{inst,gen} - n_{i,r,t}^{ret} C_i^{inst,ret}) \quad \forall t \geq 1$
- (b) Change in transmission network
  - $nt_{l,t} = 1 \quad \forall l, t \geq 1, P_{l,t} \neq 0, nt_{l,t-1} = 0$

- $reward_t + = \sum_l |nt_{l,t-1}=0, nt_{l,t}=1| C_l^{inst,trans} \quad \forall t \geq 1$

(c) Demand Satisfaction

- $P_{(r_1,r_2)} = -P_{(r_2,r_1)}$ . 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  $avail_{r,t} < Dem_{r,t}, cost_t + = P + D.(Dem_{r,t} - avail_{r,t})^2 \quad \forall r, t \geq 1$