The master problem attempts to minimize the cost "c^t" of building new lines "*x*" plus the hourly operation costs estimated by η. This η is the value of the worst-case of hourly costs for **a certain network**, assuming producers are still making optimal decisions to mitigate the scenarios. η develops as a closer and closer upper bound to the true worst-case hourly costs for **any network** as the main problem iterates. The algorithm takes in values of generation capacity "Gen_g^{max}" and demand "Dem_d^{max}" from the subproblem and outputs "x^*", the choice of lines that minimize the costs, as well as a new lower bound to the final optimization

The formulation of the master problem, assuming the same model conditions as in [1], follows. See [2] for further details. Every "*pth*" iteration of the mater problem will take in $Gen_{g,p}$ and $Dem_{d,p}$ as parameters and will add a new set of the variables to consider in the solve:
flow ($Flow_{l,p}$)
load shedding ($Shed_{d,p}$)
generation ($Gen_{g,p}$)

Then, a copy of the feasibility constraints, listed below, are added appended to problem. Keep in mind, the minimization is not just against the last iteration of the subproblem, "*k*", but rather against every iteration of the subproblem $p = 1 \dots k$, adding new variables and constraints for ever p. Thus, at iteration "*k*":

$$\min_{x,y_p} c^t x + \eta$$

$$\sum_g Gen_{g,p} - \sum_{l|s(l)=n} Flow_{l,p} + \sum_{l|r(l)=n} Flow_{l,p} = \sum_d \left(Dem_{d,p} - Shed_{d,p}\right) \ \forall n, \forall p \ \leq k$$

$$0 \leq Gen_{g,p} \leq Gen_g^{max} \ \ \forall g, \forall p \ \leq k$$

$$0 \leq Shed_{d,p} \leq Dem_d^{max} \ \ \forall d, \forall p \ \leq k$$

$$Flow_l = x(Sus_l)(\theta_{s(l),p} - \theta_{r(l),p}) \ \ \forall l, \forall p \ \leq k$$

$$-Cap_l \leq Flow_{l,p} \leq Cap_l \ \forall l, \forall p \ \leq k$$

$$-\pi \leq \theta_{n,p} \leq \pi \ \ \forall n, \forall p \ \leq k$$

$$\theta_{n,p} = 0 \ n{:}\, ref$$

$$\eta \geq \sigma * \left[\sum_g C_g^E * Gen_{g,p} + \sum_d C_d^D * Shed_{d,p} \right] \forall p \leq k$$

"Cap" is the max capacity of any line, and "Sus" is the electrical susceptance of a line. As can be seen, the number of variables in the linear solve at each iteration grows by the sum of the sizes vectors of $Flow$, $Shed$, and Gen. Constraints also grow by a similar factor.

References

[1] Antonio J. Conejo, Luis Baringo Morales, S. Jalal Kazempour, and Afzal S. Siddiqui. 2016. Investment in Electricity Generation and Transmission: Decision Making Under Uncertainty (1st ed.). Springer Publishing Company, Incorporated.

[2] Ruiz, C, and A.J Conejo. "Robust Transmission Expansion Planning." *European Journal of Operational Research*, vol. 242, no. 2, 2015, pp. 390–401.