

$$\begin{aligned} \rightarrow & \min \lambda_0 \left(\sum_{i \in I} \sum_{k \in K} F_{ik} Y_{ik} + \sum_{i \in I} F_i^c Y_i^c \right) + \lambda_1 \sum_{i \in I} \sum_{j \in J} C_{ij} X_{ij} + \lambda_2 \sum_{i \in I} \sum_{j \in J} \Pi \delta_{ij} + \lambda_3 \rho \\ \text{subject to} & \\ & \sum_{i \in I} Y_{ia} + Y_i^c + Y_i^{NC} = 1 \quad \forall i \in I \quad (6) \\ & \sum_{i \in I} X_{ij} + V_j = POP_j \quad \forall j \in J \quad (7) \\ & \sum_{j \in J} X_{ij} + U_i = (Q_i Y_i^{NC} + \sum_{i \in I} Q_{ia} Y_{ia}) \quad \forall i \in I \quad (8) \\ & X_{ij} \leq a_{ij}(POP_j) \quad \forall i \in I, \forall j \in J \quad (9) \\ & Y_i^c = 0 \quad \forall i \in I_e \quad (10) \\ & X_{ij} - \bar{X}_{ij} = \delta_{ij}^+ - \delta_{ij}^- \quad \forall i \in I, \forall j \in J \quad (11) \\ & U_i \leq \alpha_i(Q_i Y_i^{NC} + \sum_{i \in I} Q_{ia} Y_{ia}) \quad \forall i \in I \quad (12) \\ & V_j \leq \beta(POP_j) \quad \forall j \in J \quad (13) \\ & \sum_{i \in I} \sum_{j \in J} C_{ij} X_{ij} \leq \rho \quad \forall j \in J \quad (14) \\ & \rho \geq 0 \quad (15) \\ & X_{ij}, U_i, V_j, \delta_{ij}^+, \delta_{ij}^- \geq 0, \text{ EVERY} \quad \forall i \in I, \forall j \in J \quad (16) \\ & Y_i^c, Y_i^{NC} \in \{0, 1\} \quad \forall i \in I \quad (17) \end{aligned}$$

MP

$$\begin{aligned} \min & \lambda_0 \left(\sum_{i \in I} \sum_{k \in K} F_{ik} Y_{ik} + \sum_{i \in I} F_i^c Y_i^c \right) + \phi \\ \text{st} & \\ & \sum_{i \in I} Y_{ia} + Y_i^c + Y_i^{NC} = 1 \quad \forall i \\ & \sum_{i \in I} Y_{ia} + Y_i^c = 1 \quad \forall i \in I_e \\ & \phi \geq 0 \quad (\text{AUX VAR.}) \end{aligned}$$

$\phi \geq f_n. of \ Y_i^c, Y_i^{NC}, Y_{i1}$

Construct BD cut:

$$\phi \geq \dots$$

Y_i^c, Y_i^{NC}, Y_{i1}

PSP

$$\begin{aligned} Z_{PSP} = & \\ \min & \lambda_1 \sum_{i,j} C_{ij} X_{ij} + \lambda_2 \sum_{i,j} \Pi \delta_{ij} + \lambda_3 \rho \\ \text{st} & (7), (8), (9), (11), (12), (13), (14) \end{aligned}$$

DSP

$$Z_{DSP} = \dots$$

$$Z_{PSP}^* = Z_{DSP}^*$$

Comes from

$$Z_{LB} = Z_{MP}^*$$

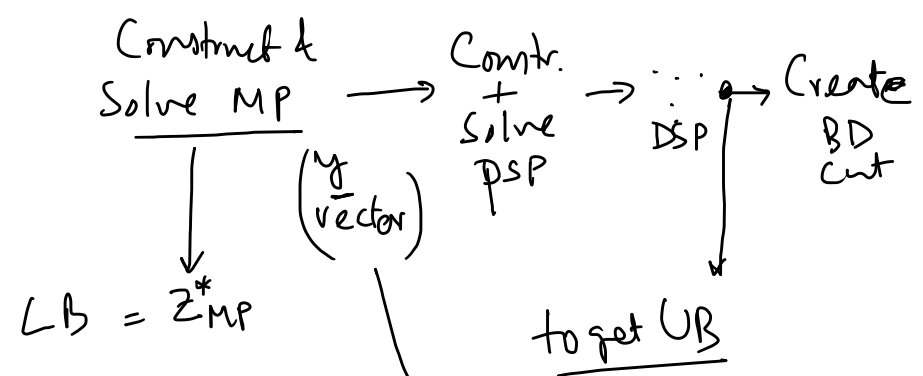
$$Z_{UB} =$$

$$\% gap = \left(\frac{Z_{UB} - Z_{LB}}{Z_{LB}} \right) \times 100\%$$

if gap \leq 2%
STOP.

"minimization"

Loop
Iter 1:



Plug-in Y vector
in the Whole Model.

$$cal UB(\hat{Y})$$

fixing
variables

$$Y_i^c \leftarrow \hat{Y}_i^c$$

Z_{UB} = Z value from whole model, after fixing Y's