$$a \in \{\mathrm{HVN}, \mathrm{JFK}, \mathrm{LGA}, \mathrm{EWR}\}, \quad m \in \{\mathrm{drive}, \mathrm{ride}, \mathrm{rail}\}, \quad s \in \mathcal{S}, \quad k \in \mathcal{I}_{a \to d}, \quad \tau \in \mathcal{T}.$$

Airports a, modes m, segments s, itineraries k, day/state τ.

$$\mathrm{VOT}_{\mathrm{ppm}} = \frac{N_A v_A + N_C v_C}{60}, \quad \lambda \in [0,1], \quad r \in \{1,2\}.$$

VOT (USD/min); λ down-weights child time; r legs.

$$\mathrm{GC}_{i,a}(m) = \mathrm{Cash}_{i,a}(m) + \mathrm{TimeVal}_{i,a}(m) + \mathrm{Risk}_{i,a}(m) \tag{1}$$

$$+ \mathrm{Sched}_{i,a}(m) + \mathrm{Xfer}_{i,a}(m) + \mathrm{Comfort}_{i,a}(m) + \mathrm{Carbon}_{i,a}(m). \tag{2}$$

All-in door→curb disutility for mode m.

$$\widetilde{\mathrm{GC}}_{i,a} = -\frac{1}{\mu_A} \ln \sum_m \exp\big(-\mu_A \, \mathrm{GC}_{i,a}(m)\big), \tag{3}$$

$$A_{i,a} = \exp\big(-\beta_A \, \widetilde{\mathrm{GC}}_{i,a}\big). \tag{4}$$

Soft-min across modes; $A_{i,a}$ converts access cost to a multiplicative utility factor.

$$T_k = \mathrm{block}_k + \mathrm{layover}_k, \tag{5}$$

$$\Phi_{\mathrm{conn}}(L_k, s_k) = \alpha_{\mathrm{short}}(L^* - L_k)_+ + \alpha_{\mathrm{long}}(L_k - U^*)_+ + \alpha_s s_k, \tag{6}$$

$$\Phi_{\mathrm{hod}}(t_k^{\mathrm{dep}}, t_k^{\mathrm{arr}}) = \eta_{\mathrm{red}} \mathbf{1}_{\text{red-eye}} + \eta_{\mathrm{curfew}} \mathbf{1}_{\text{early/late}}. \tag{7}$$

Elapsed time; layover quality; hour-of-day disutility.

$$R_k = (1 - \mathrm{CancelRate}_k)\,[1 - \pi_{\mathrm{mis}}(L_k)] \tag{8}$$

$$\times \exp\big(-\beta_D \, \mathbb{E}[\mathrm{Delay}_k^+] - \beta_V \, \mathrm{Var}[\mathrm{Delay}_k]\big), \tag{9}$$

$$R_h = \exp\big(-\beta_W \, \mathrm{WxRisk}_h - \beta_C \, \mathrm{CapacityRisk}_h\big), \tag{10}$$

$$\pi_{\mathrm{mis}}(L_k) = \mathbb{P}\big\{\mathrm{InboundDelay} + \mathrm{TaxiIn} > L_k - \mathrm{MCT}_h\big\}. \tag{11}$$

Itinerary reliability, hub risk, misconnect probability.

$$\mathrm{REC}_k = \exp\Big(- \beta_{\mathrm{rec}} \cdot \mathbb{E}[\mathrm{ReprotectTime}_k]\Big) \cdot \big(1 + \xi \cdot N_{\mathrm{alt}}(h, \Delta)\big). \tag{12}$$

Penalty for slow reprotection; credit for alternates within window Δ.

$$P_k = \exp\big(\beta_Q \, q_k\big), \tag{13}$$

$$q_k = w_{\mathrm{seat}}\mathrm{SeatPitch}_k + w_{\mathrm{wifi}}\mathrm{WiFiRel}_k + w_{\mathrm{ac}}\mathbf{1}_{\mathrm{widebody}} + w_{\mathrm{prio}}\mathbf{1}_{\mathrm{priority}}. \tag{14}$$

Additive quality score, exponentiated.

$$\mathrm{AL}_k = \exp\Big(\beta_{\mathrm{ffp}}\mathrm{Rebate}_{s,k} + \beta_{\mathrm{lounge}}\mathbf{1}_{\mathrm{lounge}} + \beta_{\mathrm{pre}}\mathbf{1}_{\mathrm{TSA\_Pre}}\Big). \tag{15}$$

Elite rebates, lounge, PreCheck as multiplicative perks.

$$p^{\mathrm{eff}}_{k,s}(\tau) = \mathbb{E}[p_k(\tau)] + \mathrm{Anc}_k - \mathrm{Rebate}_{s,k}, \tag{16}$$

$$\Pi^{\mathrm{avail}}_k(\tau) = \mathbb{P}\{p_k(\tau) \le p^*_s, \ \text{seats} \ge n_s\}, \tag{17}$$

$$F_k(\tau, s) = \Pi^{\mathrm{avail}}_k(\tau) \cdot \exp\big(- \beta_{P,s}\, p^{\mathrm{eff}}_{k,s}(\tau)\big). \tag{18}$$

Price/availability term by state τ and segment s.

$$\sum_{\tau \in \mathcal{T}} \pi(\tau) = 1, \qquad \pi(\tau) \ge 0.$$

Mixture over day/season/storm regimes.

$$D_k = \frac{1}{1 + \mathrm{dupcount}_k} \cdot \exp\big(- \beta_{\mathrm{scar}} \cdot \mathrm{LoadFactorRisk}_k\big). \tag{19}$$

Avoid double-counting codeshares; penalize scarcity.

$$B_k = \exp\Big(- \beta_B \min_{b \in \mathcal{B}_h} \big| t^{\mathrm{hub\_arr}}_k - t^{\mathrm{bank}}_b \big|_w \Big). \tag{20}$$

Credit for arriving near a departure bank window.

$$\mathrm{IOPS}_k = \exp\Big(- \beta_{\mathrm{MCT}}(\mathrm{MCT}_h - L_k)_+\Big) \cdot \exp\big(- \beta_{\mathrm{bag}}\ \mathbb{P}\{\mathrm{BagMiss}_k\}\big). \tag{21}$$

Penalize sub-MCT and bag-miss risk.

$$W_{k,s}(\tau) = \underbrace{f_k^{\gamma}}_{\text{freq}} \exp\big(-\beta_{T,s} T_k\big) \exp\big(-\beta_{C,s} \Phi_{\text{conn}}(L_k, s_k)\big) \tag{22}$$

$$\times \exp\big(-\beta_{H,s} \Phi_{\text{hod}}(t_k^{\text{dep}}, t_k^{\text{arr}})\big) R_k R_h \, \text{REC}_k \, P_k \, \text{AL}_k \tag{23}$$

$$\times F_k(\tau, s) \, D_k \, B_k \, \text{IOPS}_k. \tag{24}$$

Single multiplicative weight: schedule, reliability, price, product, banks.

$$\text{QSI}^{+}_{i,a\to d} = A_{i,a} \sum_{s\in\mathcal{S}} w_s \sum_{\tau\in\mathcal{T}} \pi(\tau) \sum_{k\in\mathcal{I}_{a\to d}} W_{k,s}(\tau). \tag{25}$$

Access factor times itinerary mix over segments and states.

$$\text{QSI}^{+}_{i,a} = \sum_{d\in\mathcal{D}} w_d \, \text{QSI}^{+}_{i,a\to d}, \tag{26}$$

$$\Delta\text{QSI}^{+}_{i} = \text{QSI}^{+}_{i,\text{HVN}} - \min\big(\text{QSI}^{+}_{i,\text{JFK}}, \text{QSI}^{+}_{i,\text{LGA}}, \text{QSI}^{+}_{i,\text{EWR}}\big). \tag{27}$$

Airport exposure across destinations; delta vs. best NYC alternative.

$$\text{Share}_{i,a\to d} = \frac{\big(\text{QSI}^{+}_{i,a\to d}\big)^{\theta}}{\sum_{a'} \big(\text{QSI}^{+}_{i,a'\to d}\big)^{\theta}}, \qquad \theta > 0. \tag{28}$$

Logit-style conversion of QSI^{+} to market share.