*Fundamentals of Traffic Operations and Control*
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*Exercise solutions*
*On-demand transportation*
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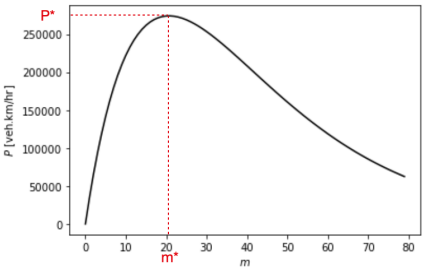


a) The equation for production is given as follows:

$$P(m) = 36000m \cdot exp\left(-\frac{29}{600}m\right)$$

To find the maximum of the production function, which also corresponds to the critical point, we solve $\frac{dP}{dm} = 0$:

$$\frac{dP}{dm} = 36000 \cdot exp\left(-\frac{29}{600}m\right)\left(1 - \frac{29}{600}m\right)$$

By setting the above derivative to 0 and solving for $m$, we get that $m^* = \frac{600}{29}$. The critical accumulation $n^*$ is hence equal to 20′690 veh. If the fleet size is equal to 3′000 veh, then the accumulation of private vehicles in the network is 17′690 veh.
b) The production under the critical condition is:

$$\begin{aligned} P^* =& 36000m^* \cdot exp(-\frac{29}{600}m^*) \\ P^* =& 36000\frac{600}{29} \cdot exp(-1) \\ P^* =& 274007 \text{ veh.km/hr} \end{aligned}$$

The trip completion rate for ride-sourcing vehicles $O_{RS}$ is:

$$\begin{aligned} O_{RS} =& 0.8\frac{n_{RS}}{n_{RS} + n_{PV}}\frac{P^*}{L_{RS}} \\ O_{RS} =& 0.8\frac{3000}{20690}\frac{274007}{1.05 \cdot 3.8} \\ O_{RS} =& 7966 \text{ veh/hr} \end{aligned}$$

Similarly, the trip completion rate for private vehicles $O_{PV}$ is:

$$\begin{aligned} O_{PV} =& \frac{n_{PV}}{n_{RS} + n_{PV}}\frac{P^*}{L_{PV}} \\ O_{PV} =& \frac{17690}{20690}\frac{274007}{3.8} \\ O_{PV} =& 61652 \text{ veh/hr} \end{aligned}$$

c) The new trip completion rate for private vehicles which we denote by $O'_{PV}$ is computed as follows:

$$\begin{aligned} O'_{PV} =& \frac{P^*}{L_{pv}} \\ O'_{PV} =& \frac{274007}{3.8} \\ O'_{PV} =& 72107 \text{ veh/hr} \end{aligned}$$

The difference between $O'_{PV}$ and $O_{PV} + O_{RS}$ is 2′489 veh/hr.
d) Pricing empty VKTs, use off-street parking for idle vehicles...