COMP9334 Revision Problems for Week 9A - Solution

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1. The decision variables are

   - $$y_i = \begin{cases} 1 & \text{if a controller is to be placed at node } i \\ 0 & \text{otherwise} \end{cases}$$

   - $$x_{ij} = \begin{cases} 1 & \text{if the controller at node } i \text{ is to control the switch at node } j \\ 0 & \text{otherwise} \end{cases}$$

   The optimisation problem is:

   $$\min \sum_{i=1}^{n} y_i$$

   subject to

   $$\begin{aligned} \sum_{i=1}^{n} x_{ij} &= 1 \ \ \forall j = 1, .., n & (1) \\ x_{ij} d_{ij} &\leq D y_i \ \ \forall i, j = 1, .., n & (2) \\ x_{ij} &\in \{0, 1\} & (3) \\ y_i &\in \{0, 1\} & (4) \end{aligned}$$

   Equation 1 enforces the constraint that a switch is associated with only one controller. Equation 2 ensures that: (i) If $y_i = 0$, i.e. there is no controller at node i, then $x_{ij} = 0$; (ii) If $y_i = 1$, then any switch that is connected to the controller at node i must have a communication delay of less than D. Equation 2 has combined (i) and (ii) into a set of inequalities. Alternatively, you can use

   $$\begin{aligned} x_{ij} &\leq y_i \ \ \forall i, j = 1, .., n & (5) \\ x_{ij} d_{ij} &\leq D \ \ \forall i, j = 1, .., n & (6) \end{aligned}$$

   to separately enforce the conditions (i) and (ii).