# COMP9334 Solution to Revision Problems for Week 8B

Chun Tung Chou

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1. (a) The decision variables are
   - $x_{ij1} = 1$ if the primary path uses link $(i, j)$, otherwise 0
   - $x_{ij2} = 1$ if the backup path uses link $(i, j)$, otherwise 0

   The object is to minimise

$$\sum_{(i,j)\in E} c_{ij}(x_{ij1} + x_{ij2}) \tag{1}$$

   subject to

$$\begin{aligned}
\sum_{j:(i,j)\in E} x_{ijk} - \sum_{j:(j,i)\in E} x_{jik} &= \begin{cases} 1 & \text{if } i = n_1 \\ 0 & \text{if } i \in N - \{n_1, n_2\} \\ -1 & \text{if } i = n_2 \end{cases} && k = 1, 2 \\
\sum_{(i,j)\in E} d_{ij} x_{ij1} &\leq d_{\max} \\
\sum_{(i,j)\in E} d_{ij} x_{ij2} &\leq d_{\max} \\
(x_{ij1} + x_{ij2})b &\leq r_{ij} \\
x_{ij1} + x_{ij2} &\leq 1 \\
x_{ijk} &\in \{0, 1\} \text{ for all } (i, j) \in E, k = 1, 2
\end{aligned}$$

   (b) The paths are 1−6−5−4 and 1−2−6−3−4. AMPL files are in `disjoint_hw.dat, disjoint_hw.mod` and `disjoint_hw_batch`