

Assignment-1: Problem Statement

The advertising manager of a magazine faces the following problem: For week $t, t = 1, 2, \dots, 13$, the manager has been allocated a maximum of n_t pages to use for advertising. The Manager has received requests r_1, r_2, \dots, r_B for advertising, where bid $r_k = (i_k, d_k, a_k, p_k)$ indicating:

- the initial week i_k to run the ad,
- the duration d_k of the advertisement (in weeks),
- the page allocation a_k of the advertisement (half-, quarter-, or full-page),
- a price offer p_k

The manager must determine which bids to accept to maximize revenue, subject to the following restrictions:

- Any advertisement that is accepted must be run in consecutive weeks throughout its duration.
- The manager cannot accept conflicting advertisement (CA). Formally, subsets T_j and T_j^c for $j = 1, 2, \dots, n$ of the bids are given, and the manager may not select an advertisement from both T_j and T_j^c ($j = 1, 2, \dots, n$). For example, if $T_1 = \{r_1, r_2\}, T_1^c = \{r_3, r_4, r_5\}$, and bid r_1 or r_2 is accepted, then bids in T_1^c i.e., r_3, r_4 and r_5 must be rejected; if bid r_3, r_4 or r_5 is accepted, then bids r_1 and r_2 must both be rejected.
- The manager must meet the Federal Communication Commissions balanced advertising requirements (BAR). Formally, subsets S_j and S_j' for $j = 1, 2, \dots, m$ of the bids are given; if the manager selects a bid from S_j , (s)he must also select a bid from S_j' ($j = 1, 2, \dots, m$). For example, if $S_1 = \{r_1, r_3, r_8\}$ and $S_1' = \{r_4, r_6\}$, then either request r_4 or r_6 must be accepted if any of the bids r_1, r_3 , or r_8 are accepted.

Formulate an ILP. Submit a writeup (in L^AT_EX) of the formulation describing ideas and assumptions behind the formulation. Implement the ILP using Python and cplex. The program must take the input from a file and write outputs to another file. The file formats are given below.

Input file format:

```
n1 n2 ... n13
r1 : i1 d1 a1 p1
r2 : i2 d2 a2 p2
.
.
.
rk : ik dk ak pk
CA1 : r1 r2 : r3 r4 r5
CA2 : ... : ...
.
.
.
CAn : ... : ...
BAR1 : r1 r3 r8 : r4 r6
BAR2 : ... : ...
.
.
.
BARm : ... : ...
END
```

Output file format:

```
Week1 : r? r? ... r?
Week2 : r? r? ... r?
.
.
.
Week13 : r? r? ... r?
```