

Problem Statement:

Introduction:

Pilots schedule consist of flight sequences called pairings. For simplicity we assume pairing is a sequence of flights (two or more) that starts and ends at the same airport (being crew home base). After pairing there must be required rest period.

Problem:

There was a hurricane forecast and many flights were cancelled. Pilots cannot continue flying with their original schedule (pairings) as with flight cancellation, pairings usually become corrupted (missing flights connections, or same airport start and end requirement). Thus, other flights from the original pairings cannot be flown if current schedules remains unchanged. In this situation, airline recovery system generated new set of pairings from all non-cancelled flights (containing all possible pairings), however due to huge number of possibilities, system couldnt build new schedules for pilots. Airline asked OR expert for help.

You are responsible for building new schedules for pilots using pregenerated flight sequences (pairings), minimizing the cost, with following objectives and constraints in mind:

Objectives:

- As many *flights* as possible should be covered (pilot assigned)
- Pilots should keep as much of their original schedule as possible (minimize total number of off-plan pairings)
- Number of pilots with schedule changes should be minimized (minimize number of modified pilots schedules)

Constraints:

- Flight can be assigned to maximum one pilot.
- After each pairing, there must be at least 10 hours rest (i.e. consecutive assignments should be separated at least 10 hours)
- As airline would like to keep pool of pilots available for other possible task/disruptions, 20% (rounded up) pilots should have their schedules cleared (all pairings removed)

Parameters:

R_s, R_e , integer parameters. Respectively start time and end time (minutes from 01.01.1970) of period for schedule generation. Assumption is all flights, pairings, schedules are contained within the period

C - set of crew (pilots)

F - set of non-cancelled flights

P - set of pairings generated from flights F

p_{if} - binary coefficient. $p_{if} = 1$ if and only if pairing i includes flight f

s_{ic} - binary coefficient. $s_{ic} = 1$ if and only if pairing i was on original schedule of crew c

s_i, e_i - integer coefficients. Respectively start time and end time (minutes from 01.01.1970) of pairing i

c_u - cost of unassigned flight

c_a - cost of assigning pairing that was not on original plan

c_d - cost of deassigning pairing that was on original plan

c_m - unit cost if pilot original schedule was modified

Tasks:

- Formulate the problem as Integer Programming (IP) model
- Assuming there must be two pilots on a flight. How the model formulation would change?
- How would you tackle solving this model, considering that enumerated set of possible pairings can be large?