

hw1_code

February 2, 2026

```
[2]: import pyomo.environ as pyo
```

```
[3]: SOLVER = pyo.SolverFactory("appsi_highs")
      assert SOLVER.available(), "not available"
```

```
[9]: model = pyo.ConcreteModel("IMRT")

      X = range(1,8) # days

      model.x = pyo.Var(X, domain = pyo.NonNegativeReals)

      model.num_nurses = pyo.Objective(
          expr = sum(model.x[i] for i in X),
          sense = pyo.minimize
      )

      model.day1 = pyo.Constraint(expr = model.x[1] + model.x[4] + model.x[5] + model.
          ↪x[6] +model.x[7] >= 100)
      model.day2 = pyo.Constraint(expr = model.x[1] + model.x[2] + model.x[5] + model.
          ↪x[6] +model.x[7] >= 90)
      model.day3 = pyo.Constraint(expr = model.x[1] + model.x[2] + model.x[3] + model.
          ↪x[6] +model.x[7] >= 80)
      model.day4 = pyo.Constraint(expr = model.x[1] + model.x[2] + model.x[3] + model.
          ↪x[4] +model.x[7] >= 80)
      model.day5 = pyo.Constraint(expr = model.x[1] + model.x[2] + model.x[3] + model.
          ↪x[4] +model.x[5] >= 100)
      model.day6 = pyo.Constraint(expr = model.x[6] + model.x[2] + model.x[3] + model.
          ↪x[4] +model.x[5] >= 50)
      model.day7 = pyo.Constraint(expr = model.x[6] + model.x[7] + model.x[3] + model.
          ↪x[4] +model.x[5] >= 30)
```

```
[10]: SOLVER.solve(model)
```

```
[10]: {'Problem': [{'Lower bound': 110.0, 'Upper bound': 110.0, 'Number of
objectives': 1, 'Number of constraints': 0, 'Number of variables': 0, 'Sense':
'minimize'}], 'Solver': [{'Status': 'ok', 'Termination condition': 'optimal',
'Termination message': 'TerminationCondition.optimal'}], 'Solution':
```

```
[OrderedDict({'number of solutions': 0, 'number of solutions displayed': 0})]]}
```

```
[11]: model.display()
```

Model IMRT

Variables:

```
x : Size=7, Index={1, 2, 3, 4, 5, 6, 7}
   Key : Lower : Value : Upper : Fixed : Stale : Domain
   1 :      0 :  60.0 :   None : False : False : NonNegativeReals
   2 :      0 :   0.0 :   None : False : False : NonNegativeReals
   3 :      0 :  10.0 :   None : False : False : NonNegativeReals
   4 :      0 :  10.0 :   None : False : False : NonNegativeReals
   5 :      0 :  20.0 :   None : False : False : NonNegativeReals
   6 :      0 :  10.0 :   None : False : False : NonNegativeReals
   7 :      0 :   0.0 :   None : False : False : NonNegativeReals
```

Objectives:

```
num_nurses : Size=1, Index=None, Active=True
   Key : Active : Value
   None :      True : 110.0
```

Constraints:

```
day1 : Size=1
   Key : Lower : Body : Upper
   None : 100.0 : 100.0 : None
day2 : Size=1
   Key : Lower : Body : Upper
   None :  90.0 :  90.0 : None
day3 : Size=1
   Key : Lower : Body : Upper
   None :  80.0 :  80.0 : None
day4 : Size=1
   Key : Lower : Body : Upper
   None :  80.0 :  80.0 : None
day5 : Size=1
   Key : Lower : Body : Upper
   None : 100.0 : 100.0 : None
day6 : Size=1
   Key : Lower : Body : Upper
   None :  50.0 :  50.0 : None
day7 : Size=1
   Key : Lower : Body : Upper
   None :  30.0 :  50.0 : None
```

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[ ]:
```