

Week 5

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Assignment 1-Trucks

Six trucks have to deliver pallets of obscure building blocks to a magic factory.

- Every truck has a capacity of 8000 kg and can carry at most eight pallets.
- In total, the following has to be delivered:
 - Four pallets of nuzzles, each of weight 800 kg.
 - A number of pallets of prittles, each of weight 1300 kg.
 - Eight pallets of skipples, each of weight 1000 kg.
 - Eight pallets of crottles, each of weight 1500 kg.
 - Twelve pallets of dupples, each of weight 400 kg.
- Skipples need to be cooled; only two of the six trucks have the facility for cooling skipples.
- Nuzzles are very valuable; to distribute the risk of loss no two pallets of nuzzles may be in the same truck.
- to find a maximum:
 - use `(maximize N) (outside asserts)`
- describe the model + your clauses
- give a table how the trucks are loaded

The screenshots below show the entirety of the code along with informative comments, ending with the output table

```

# n-nuzzle, p-prittle, s-skipple, c-crottle, d-dupple
pallet, (n,p,s,c,d) = EnumSort('pallet', ['n', 'p','s','c','d'])

carry=IntSort()
number=IntSort()
#truck has a number, and a certain number of type of pallets it carries
truck=Function('truck',number,pallet,carry)

maxWeight,maxPallets=Ints('maxWeight maxPallets')

#number of each pallet
noN,noP,noS,noC,noD=Ints('noN noP noS noC noD')

#for iterating
i=Int('i')

#1-weight of all possible combined pallets per truck smaller than maxWeight
def checkTruckWeight():
    return(
        ForAll(i,
            truck(i,n)*800+truck(i,p)*1300+truck(i,s)*1000+truck(i,c)*1500+truck(i,d)*400<=maxWeight
        )
    )

#2-each pallet type must be greater than 0
def minPalletsPerTruck():
    return(
        ForAll(i,
            And(
                truck(i,n)>=0,
                truck(i,p)>=0,
                truck(i,s)>=0,
                truck(i,c)>=0,
                truck(i,d)>=0,
            )
        )
    )

#3-total number of pallets in a truck <=8
def maxPalletsPerTruck():
    return(
        ForAll(i,
            truck(i,n)+truck(i,p)+truck(i,s)+truck(i,c)+truck(i,d)<=maxPallets
        )
    )

#4-max 2 trucks have skipples
def truckSkipple():
    return(
        And(
            truck(1,s)==0,
            truck(2,s)==0,
            truck(3,s)==0,
            truck(4,s)==0,
        )
    )

```

```

#5-max 1 nuzzle per truck
def truckNuzzle():
    return(
        ForAll(i,
            truck(i,n)<=1
        )
    )

# slv=Solver()
slv=Optimize()

#max weight,pallets
slv.add(maxWeight==8000)
slv.add(maxPallets==8)

#number of pallets per category
slv.add(noN==4) #total weight of nuzzle 4*800=3200
slv.add(noS==8) #total weight of skipple 8*1000=8000
slv.add(noC==8) #total weight of crottle 8*1500=12000
slv.add(noD==12) #total weight of duple 12*400=4800
#for prittles we have unknown number but we know total max capacity of trucks to be 6*8000=48000
#48000-3200-8000-12000-4800= 20000 max weight for prittle
# 20000/1300 ~ max 15 skipples
slv.add(noP==15)

#constraints from the methods above
slv.add(checkTruckWeight())
slv.add(minPalletsPerTruck())
slv.add(maxPalletsPerTruck())
slv.add(truckSkipple())
slv.add(truckNuzzle())

#each pallet from all possible trucks must sum up the the number of pallets
slv.add( truck(1,n)+truck(2,n)+truck(3,n)+truck(4,n)+truck(5,n)+truck(6,n)==noN )
slv.add( truck(1,p)+truck(2,p)+truck(3,p)+truck(4,p)+truck(5,p)+truck(6,p)==noP )
slv.add( truck(1,s)+truck(2,s)+truck(3,s)+truck(4,s)+truck(5,s)+truck(6,s)==noS )
slv.add( truck(1,c)+truck(2,c)+truck(3,c)+truck(4,c)+truck(5,c)+truck(6,c)==noC )
slv.add( truck(1,d)+truck(2,d)+truck(3,d)+truck(4,d)+truck(5,d)+truck(6,d)==noD )

print(slv.check())
# print(slv.model())
m = slv.model()
# print(m)

```

```

print("          ", "nuzzles", "prittles", "skipples", "crottles", "dupples", "weight")
for j in range(1,7):
    print(
        'truck', j, "          ",
        m.evaluate(truck(j,n)), "          ", |
        m.evaluate(truck(j,p)), "          ",
        m.evaluate(truck(j,s)), "          ",
        m.evaluate(truck(j,c)), "          ",
        m.evaluate(truck(j,d)), "          ",
        m.evaluate(truck(j,n)*800+truck(j,p)*1300+truck(j,s)*1000+truck(j,c)*1500+truck(j,d)*400)
    )

```

```

sat
      nuzzles prittles skipples crottles dupples weight
truck 1      0       4       0       1       3      7900
truck 2      0       4       0       1       3      7900
truck 3      1       0       0       4       3      8000
truck 4      1       5       0       0       1      7700
truck 5      1       1       4       1       1      8000
truck 6      1       1       4       1       1      8000

```

The picture above shows the result of the solver and how each truck is loaded, as well as the weight of that truck. We can see that the constraints for skipples and nuzzles are respected and that all of the pallets are loaded without any missing

Assignment 2- a,b values

Completed in week 4

Assignment 3- 5x5 Rooks

Completed in week 4