5

October 1, 2023

[ ]:
```
using JuMP
```

[ ]:
```
using CPLEX
```

[ ]:
```
model=Model(CPLEX.Optimizer)
```

```
A JuMP Model
Feasibility problem with:
Variables: 0
Model mode: AUTOMATIC
CachingOptimizer state: EMPTY_OPTIMIZER
Solver name: CPLEX
```

[ ]:
```
d = 500
```

```
500
```

[ ]:
```
a = [6 5 4] # Walking speed of students
```

```
1×3 Matrix{Int64}:
 6  5  4
```

[ ]:
```
b = [14 15 16]  # Biking speed of students
```

```
1×3 Matrix{Int64}:
 14  15  16
```

[ ]:
```
@variable(model, x[1:3],lower_bound=0) # Distance for which each student will␣
↪use bicycle
```

```
3-element Vector{VariableRef}:
 x[1]
 x[2]
 x[3]
```

[ ]:
```
@constraint(model, sum(x) == d)
```

$$x_1 + x_2 + x_3 = 500$$

[ ]:
```
t= [(x[i] / b[i] + (d-x[i])/a[i]) for i in 1:3] # Time array is defined
```

```
3-element Vector{AffExpr}:
 -0.09523809523809523 x[1] + 83.33333333333333
 -0.13333333333333336 x[2] + 100
 -0.1875 x[3] + 125
```

[ ]:
```
# Define a variable to represent the maximum of t
@variable(model, max_t)
```

$$max\_t$$

[ ]:
```
# Add constraints to ensure that max_t is greater than or equal to all t values
for i in 1:3
    @constraint(model, max_t >= t[i])   # max_t will be greater than or equal␣
 ↪to than the time taken by the last student.
end
```

[ ]:
```
@objective(model,Min, max_t)
```

$$max\_t$$

[ ]:
```
@show model
```

```
model = A JuMP Model
Minimization problem with:
Variables: 4
Objective function type: VariableRef
`AffExpr`-in-`MathOptInterface.EqualTo{Float64}`: 1 constraint
`AffExpr`-in-`MathOptInterface.GreaterThan{Float64}`: 3 constraints
`VariableRef`-in-`MathOptInterface.GreaterThan{Float64}`: 3 constraints
Model mode: AUTOMATIC
CachingOptimizer state: EMPTY_OPTIMIZER
Solver name: CPLEX
Names registered in the model: max_t, x
```

```
A JuMP Model
Minimization problem with:
Variables: 4
Objective function type: VariableRef
`AffExpr`-in-`MathOptInterface.EqualTo{Float64}`: 1 constraint
`AffExpr`-in-`MathOptInterface.GreaterThan{Float64}`: 3 constraints
`VariableRef`-in-`MathOptInterface.GreaterThan{Float64}`: 3 constraints
Model mode: AUTOMATIC
CachingOptimizer state: EMPTY_OPTIMIZER
Solver name: CPLEX
Names registered in the model: max_t, x
```

[ ]:
```
optimize!(model)
```

```
CPLEX Error  3003: Not a mixed-integer problem.
Version identifier: 22.1.1.0 | 2022-11-26 | 9160aff4d
Tried aggregator 1 time.
No LP presolve or aggregator reductions.
Presolve time = 0.00 sec. (0.00 ticks)
Initializing dual steep norms . . .

Iteration log . . .
Iteration:     1   Scaled dual infeas =             0.133332
Iteration:     3   Dual objective     =            71.428571
```

[ ]:
```
@show value.(x)
```

```
value.(x) = [68.75000000000011, 174.10714285714272, 257.14285714285717]

3-element Vector{Float64}:
  68.75000000000011
 174.10714285714272
 257.14285714285717
```

[ ]:
```
@show objective_value(model) # Minimum time
```

```
objective_value(model) = 76.78571428571428

76.78571428571428
```