

Example 3.4. A family farm has 625 acres available for planting. The crops the family is considering are corn, wheat, and oats. It is anticipated that 1,000 acre-ft of water will be available for irrigation, and the farmers will be able to devote 300 hours of labor per week. Additional data are presented in Table 3.2. Find the amount of each crop that should be planted for maximum profit.

Objective function: Maximize Yield.

$$y(x_1, x_2, x_3) = 400x_1 + 200x_2 + 250x_3$$

$$l(x_1, x_2, x_3) = 0.8x_1 + 0.2x_2 + 0.3x_3$$

$$w(x_1, x_2, x_3) = 3.0x_1 + 1.0x_2 + 1.5x_3$$

$$a(x_1, x_2, x_3) = x_1 + x_2 + x_3$$

$$l(x_1, x_2, x_3) \leq 300$$

$$w(x_1, x_2, x_3) \leq 1000$$

$$a(x_1, x_2, x_3) \leq 625$$

$$x_1 \geq 0, \quad x_2 \geq 0, \quad x_3 \geq 0$$

	acres planted	x_1	x_2	x_3
Requirements		Corn	Wheat	Oats
per acre				
Irrigation w	(acre-ft)	3.0	1.0	1.5
Labor l	(person-hrs/week)	0.8	0.2	0.3
Yield y	(\$)	400	200	250

```
julia> using JuMP
julia> using HiGHS
julia> y(x1,x2,x3)=400*x1+200*x2+250*x3
y (generic function with 1 method)
julia> l(x1,x2,x3)=0.8*x1+0.2*x2+0.3*x3
l (generic function with 1 method)
julia> w(x1,x2,x3)=3.0*x1+1.0*x2+1.5*x3
w (generic function with 1 method)
julia> a(x1,x2,x3)=x1+x2+x3
a (generic function with 1 method)
```

```
julia> model=Model(HiGHS.Optimizer)
A JuMP Model
├ solver: HiGHS
├ objective_sense: FEASIBILITY_SENSE
├ num_variables: 0
├ num_constraints: 0
└ Names registered in the model: none

julia> @variable(model, x1>=0)
x1
julia> @variable(model, x2>=0)
x2
julia> @variable(model, x3>=0)
x3
```

```
julia> print(model)
Feasibility
Subject to
x1 ≥ 0
x2 ≥ 0
x3 ≥ 0
```

can print the model at any time

```
julia> @objective(model, Max, y(x1, x2, x3))
400 x1 + 200 x2 + 250 x3
```

maximize

Yield..

label the constraint in case I want to change it later

```
julia> @constraint(model, c1, l(x1, x2, x3) <= 300)
c1 : 0.8 x1 + 0.2 x2 + 0.3 x3 ≤ 300

julia> @constraint(model, c2, w(x1, x2, x3) <= 1000)
c2 : 3 x1 + x2 + 1.5 x3 ≤ 1000

julia> @constraint(model, c3, a(x1, x2, x3) <= 625)
c3 : x1 + x2 + x3 ≤ 625
```

```
julia> print(model)
Max 400 x1 + 200 x2 + 250 x3
Subject to
c1 : 0.8 x1 + 0.2 x2 + 0.3 x3 ≤ 300
c2 : 3 x1 + x2 + 1.5 x3 ≤ 1000
c3 : x1 + x2 + x3 ≤ 625
x1 ≥ 0
x2 ≥ 0
x3 ≥ 0
```

Assumptions: $w = 3.0x_1 + 1.0x_2 + 1.5x_3$
 $l = 0.8x_1 + 0.2x_2 + 0.3x_3$
 $t = x_1 + x_2 + x_3$
 $y = 400x_1 + 200x_2 + 250x_3$
 $w \leq 1,000$
 $l \leq 300$
 $t \leq 625$
 $x_1 \geq 0; x_2 \geq 0; x_3 \geq 0$

Objective: Maximize y

```
julia> optimize!(model)
Running HiGHS 1.13.1 (git hash: 1d267d97c): Copy
license terms
Using BLAS: blastrampoline
LP has 3 rows; 3 cols; 9 nonzeros
Coefficient ranges:
  Matrix [2e-01, 3e+00]
  Cost   [2e+02, 4e+02]
  Bound  [0e+00, 0e+00]
  RHS    [3e+02, 1e+03]
Presolving model
3 rows, 3 cols, 9 nonzeros 0s
3 rows, 3 cols, 9 nonzeros 0s
Presolve reductions: rows 3(-0); columns 3(-0);
Problem not reduced by presolve: solving the LP
Using dual simplex solver
  Iteration   Objective   Infeasibilities
          0   -8.4999940047e+02  Ph1: 3(9.8); Du
          3    1.6250000000e+05  Pr: 0(0) 0.0s

Model status      : Optimal
Simplex iterations: 3
Objective value   : 1.6250000000e+05
P-D objective error : 0.0000000000e+00
HiGHS run time    : 0.00
```

```
julia> objective_value(model)
162500.0
```

LINDO OUTPUT for same problem...

```
4) X1 + X2 + X3 <= 625
END
LP OPTIMUM FOUND AT STEP 2
OBJECTIVE FUNCTION VALUE
1) 162500.000
VARIABLE VALUE REDUCED COST
{ X1 187.500000 ? .000000
X2 437.500000 ? .000000
X3 .000000 -.000015
```

```
julia> value(x1)
41.666666666666664

julia> value(x2)
0.0

julia> value(x3)
583.3333333333333
```

corn to plant
wheat to plant
oats to plant

```
julia> y(41.666666666666664, 0.0, 583.3333333333334)
162500.0
```

```
julia> y(187.5, 437.5, 0.0)
162500.0
```

*Maximum was
not unique ...*