MP-1 TUTORIAL-4
PRE-LAB

1. State the general rules for formulating a dual LP problem from its primal?

MP-1 Tutorial-4
prelab

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1. Rules for formulating a dual:
   1. write coefficent matrix A from the coefficients of the original problem.
   2. Transpose the matrix A and change the variables
   3. write the dual problem from the transposed matrix.

2. Minimize C=5x1+2x2
   X1+3x2 >=15
   Subject To: 2x1 + x2 >= 20
   X1,x2 >=0
   Find the dual problem for the above LP model.

2. Minimize $C = 5x_1 + 2x_2$

Subject To: $x_1 + 3x_2 >= 15$
$2x_1 + x_2 >= 20$
$x_1, x_2 >= 0$

Dual of above problem is

let y_1, y_2, y_3 be the variables in dual

$y_1 + 2y_2 \leq 5$
$3y_1 + y_2 \leq 2$
$z = 15y_1 + 20y_2$
Maximize
$y_1, y_2 \geq 0$

3. Construct dual problem from primal problem.

Minimize $C = 16 x1 + 45 x2$

Subject to $2x1 + 5x2 \geq 50$

$x1 + 3x2 \geq 27$

$x1, x2 \geq 0$

Construct dual from Primal problem.

3 Minimize $C = 16x_1 + 45x_2$

Subject To: $2x_1 + 5x_2 \geq 50$

$x_1 + 3x_2 \geq 27$

$x_1, x_2 \geq 0$

Dual of above problem is

Maximize $50y_1 + 27y_2$

Subject To: $2y_1 + y_2 \leq 16$

$5y_1 + 3y_2 \leq 45$

$y_1, y_2 \geq 0$

INLAB

1. Minimize : C=21x1 + 50x2

Subject To:

2x1 + 5x2 >=12

3x1 +7x2 >=17

X1,x2 >=0

A.Formulate Linear programming model.

In-lab

1. Minimize : $C = 21x_1 + 50x_2$

subject To: $2x_1 + 5x_2 \geq 12$

$3x_1 + 7x_2 \geq 17$

$x_1, x_2 \geq 0$

Dual of above problem is

Maximize $z = 12y_1 + 17y_2$

subject To: $2y_1 + 3y_2 \leq 21$

$5y_1 + 7y_2 \leq 50$

Adding slack variables

$2y_1 + 3y_2 + x_1 = 21$

$5y_1 + 7y_2 + x_2 = 50$

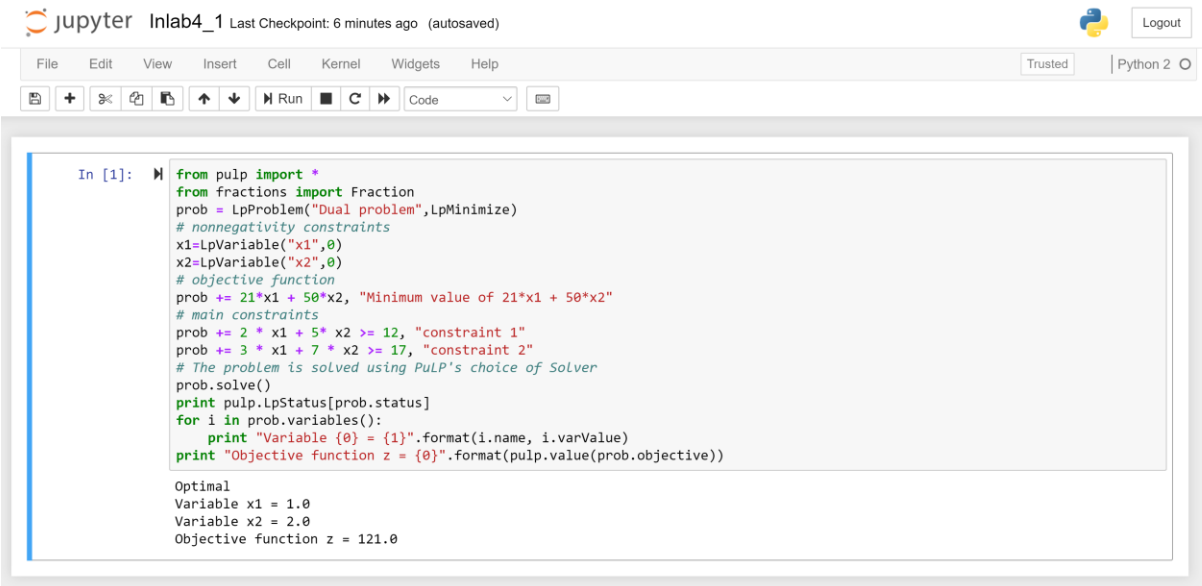
B. Solve Dual LP model using Python.

Code:

```
from pulp import *
from fractions import Fraction
prob = LpProblem("Dual problem",LpMinimize)
# nonnegativity constraints
x1=LpVariable("x1",0)
x2=LpVariable("x2",0)
# objective function
prob += 21*x1 + 50*x2, "Minimum value of 21*x1 + 50*x2"
# main constraints
prob += 2 * x1 + 5* x2 >= 12, "constraint 1"
prob += 3 * x1 + 7 * x2 >= 17, "constraint 2"
```

```
# The problem is solved using PuLP's choice of Solver
prob.solve()
print pulp.LpStatus[prob.status]
for i in prob.variables():
   print "Variable {0} = {1}".format(i.name, i.varValue)
print "Objective function z = {0}".format(pulp.value(prob.objective))
```

OUTPUT



2. A XYZ company is hired by a retailer to transport goods from its store room in A and B to its outlets stores in C and D. The XYZ company is contracted to deliver 30 vehicles each month to deliver goods. The company determines that it will need to send at least 12 of the vehicles to the ‘C’ location and at least 13 vehicles to the “D” location. At least 15 vehicles can come from the A storeroom and at least 20 vehicles can come from the “B”. The truck company wants to minimize the number of miles placed on its trucks. How many trucks should the send out from each location and to which outlets should they send them?

	A	B
C	22ml	31ml
D	20ml	38ml

A.Formulate Linear programming model.

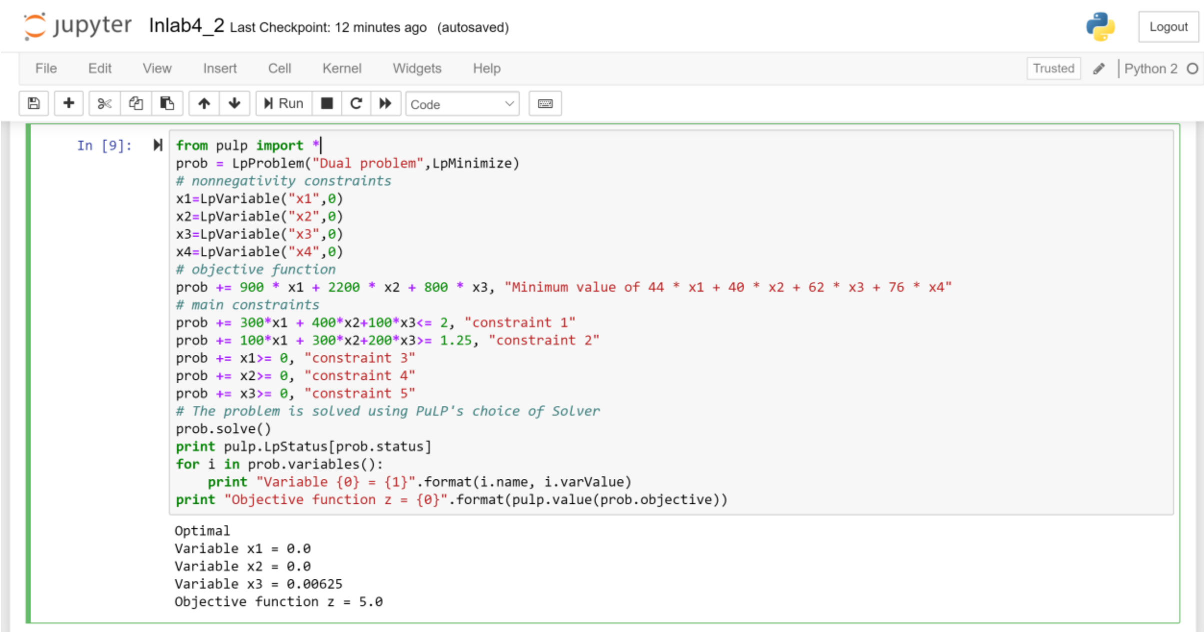
B. Solve Dual LP model using Python.

Code:

```
from pulp import *
prob = LpProblem("Dual problem",LpMinimize)
# nonnegativity constraints
x1=LpVariable("x1",0)
x2=LpVariable("x2",0)
x3=LpVariable("x3",0)
x4=LpVariable("x4",0)
# objective function
```

```
prob += 900 * x1 + 2200 * x2 + 800 * x3, "Minimum value of 44 * x1 + 40 * x2 + 62 * x3 + 76 * x4"
# main constraints
prob += 300*x1 + 400*x2+100*x3<= 2, "constraint 1"
prob += 100*x1 + 300*x2+200*x3>= 1.25, "constraint 2"
prob += x1>= 0, "constraint 3"
prob += x2>= 0, "constraint 4"
prob += x3>= 0, "constraint 5"
# The problem is solved using PuLP's choice of Solver
prob.solve()
print pulp.LpStatus[prob.status]
for i in prob.variables():
  print "Variable {0} = {1}".format(i.name, i.varValue)
print "Objective function z = {0}".format(pulp.value(prob.objective))
```

OUTPUT



POSTLAB

1. Minimize : C= 16x1+8x2+4x2
Subject To: 3x1 + 2x2 +2x3 >=16
4x1 +3x2 + x3 >=14
5x1 + 3x2 + x3 >=12
X1,x2,x3 >=0
Apply dual method and find the optimal solution for minimization problem

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1. Minimize : $C = 16x_1 + 8x_2 + 4x_3$

subject To : $3x_1 + 2x_2 + 2x_3 >= 16$

$4x_1 + 3x_2 + x_3 >= 14$

$5x_1 + 3x_2 + x_3 >= 12$

$x_1, x_2, x_3 >= 0$

Dual for above problem is

let y_1, y_2, y_3 be the variables in dual

Maximize $z = 16y_1 + 14y_2 + 12y_3$

subject To : $3y_1 + 4y_2 + 5y_3 \leq 16$

$2y_1 + 3y_2 + 3y_3 \leq 8$

$2y_1 + y_2 + y_3 \leq 4$

$y_1, y_2, y_3 \geq 0$

C_{B_1}	c_j	16	14	12	0	0	0	
.	Basic variables	y_1	y_2	y_3	x_1	x_2	x_3	Sol
0	x_1	3	4	5	1	0	0	16
0	x_2	2	3	3	0	1	0	8
0	x_3	2	1	1	0	0	1	4
	z_j	0	0	0	0	0	0	
	$c_j - z_j$	16	14	12	0	0	0	

Iteration-1

C_{B_i}	C_j	16	14	12	0	0	0	
	Basic variables	y_1	y_2	y_3	x_1	x_2	x_3	sol
0	x_1	0	5/2	7/2	1	0	-3/2	10
0	x_2	0	2	2	0	1	-1	4
16	y_1	1	1/2	1/2	0	0	1/2	2
	z_j	16	8	8	0	0	8	
	$C_j - z_j$	0	6	4	0	0	-8	

Iteration-2

C_{B_i}	C_j	16	14	12	0	0	0	
	Basic variables	y_1	y_2	y_3	x_1	x_2	x_3	sol
0	x_1	0	0	1	1	-5/2	-1/4	5
14	y_2	0	1	1	0	1/2	-1/2	2
16	y_1	1	0	0	0	-1/4	3/4	1
	z_j	16	14	12	0	3	5	
	$C_j - z_j$	0	0	0	0	-3	-5	

$x_1 = 0$ $\quad z = 44$

$x_2 = 3$

$x_3 = 5$

2. A producer of Healthy food makes two important and secret ingredients that goes into their humanfood, named as a HealthyMan and CommonMan. Each kg of HealhyMan contains 300 g of vitamins, 400 g of protein, and 100 g of carbs. Each kg of commonMan contains 100 g of vitamins, 300 g of protein, and 200 g of carbs. Guidelines for minimum nutritional that require a mixture made from these ingredients contain at least 900 g of vitamins, 2200 g of protein, and 800 g of carbs. HealthyMan costs $2.00 per kg to produce and CommonMan costs $1.25 per kg to produce. Find the number of kgs of each ingredient that should be produced in order to minimize cost.
Solve LPP by using Dual method.

2. Minimize $C = 2x_1 + 1.25\,x_2$

$$300x_1 + 100x_2 \geq 900$$
$$400x_1 + 300x_2 \geq 2200$$
$$100x_1 + 200x_2 \geq 800$$

Dual of above problem is

Maximize $Z = 900Y_1 + 2200Y_2 + 800Y_3$

Subject To: $300Y_1 + 400Y_2 + 100Y_3 \leq 2$
$100Y_1 + 300Y_2 + 200Y_3 \leq 1.25$

CBi	Cj	900	2200	800	0	0	
	Basic Variable	Y_1	Y_2	Y_3	x_1	x_2	Sol
0	x_1	300	$\boxed{400}$	100	1	0	2
0	x_2	$\boxed{100}$	$\boxed{300}$	200	0	1	1.25
	Z_j	0	0	0	0	0	
	$C_j - Z_j$	900	2200	800	0	0	

Iteration-1

C_{Bi}	c_j	900	2200	800	0	0	
	Basic variable	y_1	y_2	y_3	x_1	x_2	sol
0	x_1	$\boxed{500/3}$	0	$-100/3$	1	$-4/3$	$1/3$
2200	y_2	$\boxed{1/3}$	1	$2/3$	0	$1/200$	$1/240$
	z_j	$2200/3$	2200	$4400/3$	0	$22/3$	
	$c_j - z_j$	$500/3$	0	$-2000/3$	0	$-22/3$	

Iteration-2

C_{Bi}	c_j	900	2200	800	0	0	
	Basic variable	y_1	y_2	y_3	x_1	x_2	sol
900	y_1	1	0	-1	$3/500$	$-1/125$	$1/500$
2200	y_2	0	1	1	$-1/500$	$3/100$	$-1/1500$
	z_j	900	2200	1300	1	6	
	$c_j - z_j$	0	0	-500	-1	6	

$\therefore\ x_1 = 1 \quad x_2 = 6$

$C = 9.5$