```
/*
SAS/OR LP Procedure Example
Hillier and Liberman (2015)
Question 5.2.1 on page 193
*/

OPTIONS NODATE LINESIZE=100 PAGESIZE=50 NONUMBER;

DATA product_mix;
INPUT _ID_ $ x1 x2 x3 x4 x5 _TYPE_ $ _RHS_;
DATALINES;
Object 8 4 6 3 9 MAX .
C1       1 2 3 3 0 LE 180
C2       4 3 2 1 1 LE 270
C3       1 3 0 1 3 LE 180
;RUN;

PROC LP PARAPRINT TABLEAUPRINT RANGEPRICE RANGERHS FLOW PRINT PRINTFREQ=1 PRINTLEVEL=1;
RUN;

PROC OPTMODEL;
   VAR x{i in 1..5} >=0;
   MAX z = 8*x[1] + 4*x[2] + 6*x[3] + 3*x[4] + 9*x[5];
   CON c1: x[1]  + 2*x[2] + 3*x[3] + 3*x[4] <= 180;
   CON c2: 4*x[1] + 3*x[2] + 2*x[3] + x[4] + x[5] <=270;
   CON c3: x[1] + 3*x[2] + x[4] + 3*x[5] <=180;
   SOLVE WITH LP / SOLVER = PS PRINTFREQ=1;
   PRINT x.status x;
RUN;
```

The SAS System

The LP Procedure

Problem Summary

Objective Function	Max Object
Rhs Variable	_RHS_
Type Variable	_TYPE_
Problem Density (%)	66.67

Variables	Number
Non-negative	5
Slack	3
Total	8

Constraints	Number
LE	3
Objective	1
Total	4

The SAS System

The LP Procedure

Iteration Log

Phase	Iteration	Entering Variable	Leaving Variable	Reduced Cost	Objective Value
2	1	x1	C2	8.000000	540
2	2	x5	C3	7.000000	826.36364
2	3	x3	C1	3.272727	990

The SAS System

The LP Procedure

Solution Summary

Terminated Successfully

Objective Value	990
Phase 1 Iterations	0
Phase 2 Iterations	3
Phase 3 Iterations	0
Integer Iterations	0
Integer Solutions	0
Initial Basic Feasible Variables	5
Time Used (seconds)	0
Number of Inversions	3
Epsilon	1E-8
Infinity	1.797693E308
Maximum Phase 1 Iterations	100
Maximum Phase 2 Iterations	100
Maximum Phase 3 Iterations	99999999
Maximum Integer Iterations	100
Time Limit (seconds)	120

The LP Procedure

Variable Summary

Col	Variable Name	Status	Type	Price	Activity	Reduced Cost
1	x1	BASIC	NON-NEG	8	30	0
2	x2		NON-NEG	4	0	-9.666667
3	x3	BASIC	NON-NEG	6	50	0
4	x4		NON-NEG	3	0	-4.666667
5	x5	BASIC	NON-NEG	9	50	0
6	C1		SLACK	0	0	-1.333333
7	C2		SLACK	0	0	-1
8	C3		SLACK	0	0	-2.666667

The LP Procedure

Constraint Summary

Row	Constraint Name	Type	S/S Col	Rhs	Activity	Dual Activity
1	Object	OBJECTVE	.	0	990	.
2	C1	LE	6	180	180	1.3333333
3	C2	LE	7	270	270	1
4	C3	LE	8	180	180	2.6666667

The LP Procedure

Current Tableau

	INV(B)*R	x2	x4	C2	C3	C1
R_COSTS	.	-9.666666667	-4.666666667	-1	-2.666666667	-1.333333333
x3	50	0.5925925926	1.1481481481	-0.111111111	0.037037037	0.4074074074
x1	30	0.2222222222	-0.444444444	0.3333333333	-0.111111111	-0.222222222
x5	50	0.9259259259	0.4814814815	-0.111111111	0.3703703704	0.0740740741
PHASE_1_	0	0	0	0	0	0
Object	990	9.6666666667	4.6666666667	1	2.6666666667	1.3333333333

The SAS System

The LP Procedure

RHS Range Analysis

	Minimum Phi			Maximum Phi		
Row	Rhs	Leaving	Objective	Rhs	Leaving	Objective
C1	57.272727	x3	826.36364	315	x1	1170
C2	180	x1	900	720	x3	1440
C3	45	x5	630	450	x1	1710

The LP Procedure

Price Range Analysis

	Variable	Minimum Phi			Maximum Phi		
Col	Name	Price	Entering	Objective	Price	Entering	Objective
1	x1	5	C2	900	14	C1	1170
2	x2	-INFINITY	.	990	13.666667	x2	990
3	x3	2.7272727	C1	826.36364	15	C2	1440
4	x4	-INFINITY	.	990	7.6666667	x4	990
5	x5	1.8	C3	630	18	C2	1440
6	C1	-INFINITY	.	990	1.3333333	C1	990
7	C2	-INFINITY	.	990	1	C2	990
8	C3	-INFINITY	.	990	2.6666667	C3	990

The SAS System

The OPTMODEL Procedure

Problem Summary

Objective Sense	Maximization
Objective Function	z
Objective Type	Linear
Number of Variables	5
Bounded Above	0
Bounded Below	5
Bounded Below and Above	0
Free	0
Fixed	0
Number of Constraints	3
Linear LE (<=)	3
Linear EQ (=)	0
Linear GE (>=)	0
Linear Range	0

The SAS System

The OPTMODEL Procedure

Solution Summary

Solver	Primal Simplex
Objective Function	z
Solution Status	Optimal
Objective Value	990
Iterations	3
Primal Infeasibility	0
Dual Infeasibility	0
Bound Infeasibility	0

[1]	x.STATUS	x
1	B	30
2	L	0
3	B	50
4	L	0
5	B	50