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Solving Linear Programming Problems Using AMPL Modeling Language

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ABSTRACT

Optimization problems arise in many contexts. A modelling language like AMPL makes it easier to experiment with formulations and use the right solvers to address the resultant optimization issues. Variables, objectives, constraints, sets of possible parameters, and notations that resemble well-known mathematical notation can all be stated using AMPL. The AMPL command language enables computation and display of data regarding the specifics of a problem and the solutions provided by solvers. It also enables the modification of problem formulations and the resolution of problem chains. Both continuous and discrete optimization issues are addressed by AMPL. In this paper, AMPL is used to solve different optimization problems such as Wyndor Glass problem, Transportation and Assignment problem and Purchase Planning problem.

Keywords: Optimization, AMPL, Wyndor Glass Problem, Transportation and Assignment Problem, Purchase Planning Problem

INTRODUCTION

The term "Linear Programming" (LP), sometimes known as "Linear Optimization," refers to a technique for determining the optimal result in a mathematical model whose requirements are represented by linear relationships. Many academic disciplines can benefit from the use of linear programming. It is heavily employed in mathematics and, to a lesser extent, in issues relating to commerce, economics, and some types of engineering. Transportation, energy, telecommunications, and manufacturing are among the sectors that use linear programming models. It has proven useful in modeling diverse types of problems in planning, routing, scheduling, assignment, and design. Components of Linear Programming Problem include:

Decision Variables

Decision variables are the physical quantities used to be calculated and controlled by the decision maker and represented by mathematical symbols. These variables are the physical quantities and the decision-maker has control over them. Such variables are usually denoted by x1, x2, …, xn, where n is a finite positive integer i.e., $x1 \geq 0, x2 \geq 0, ..., xn \geq 0$.

Objective Function

The objective function of each LP problem is expressed in terms of decision variables to optimize the criterion of optimality. The objective function Z = c1x1 + + cnxn is a linear function of the n decision variables. The constants
c1, c2…...cn are real numbers that are called the coefficient of
the objective function. The objective function can be written depending on maximization or minimization. Max Z = c1x1
+ …… + cnxn or min Z = c1x1 +…+ cnxn respectively. The value of the objective function at a point x is called the objective value at x. The objective function always specifies a way of optimization, either to

minimize or maximize. In the linear function, Z = c1x1 + …… + cnxn, where c1, c2, ….cn are constants, which has to be maximized or minimized is called a linear objective function.

Non negativity

It is the most valuable part of the LP problem that makes sense of the decision variable. Non-negativity of an LP model is an inequality of the form $xi \geq 0$, and a non-positivity constraint is of form $xi \leq 0$. It may also happen that a variable xi is not restricted by a non-negativity constraint or a non-positivity constraint. In such a case, xi is known as a free or unrestricted variable.

Constraints

Constraints are limitations in the use of resources related to physical, financial, legal, technical, ethical, and other constraints that limit the extent to which goals can be achieved. For example, resources such as raw materials, labor, machinery, money, manpower, and space can affect results. Such constraints should be expressed as linear equalities or inequalities with respect to the decision variables. The conditions in the given objective function, $xi \geq 0$, $yi \geq 0$ are called non - negative restrictions and the solution of an LP problem must satisfy these constraints.

RELATED WORK

The author, David M. Gay, [3] provides an overview of AMPL and its interaction with solvers and discusses some issues transformation and implementation techniques. They also look forward to the possibilities of extending AMPL. Several mathematical programming models were presented, coded in the AMPL language, formulated and tested, and the results observed. There has been talk of an interface library (ASL) that automatically provides solver-derived details such as sparsity Information and Derivatives.

In [4] mixed-integer linear programming (MILP) is proposed to solve the problem of optimal charging coordination for electric vehicles (EV) in unbalanced power distribution systems (EDS) considering vehicle-to-grid (V2G) technology. The suggested method establishes an ideal charging plan for EVs taking into account their arrival and departure periods as well as their state of charge upon arrival. The model was written in the mathematical modeling language AMPL and solved with the commercial solver CPLEX.

The author in [5] presented the mixed integer programming model that maximizes the project's utility function. This model shows the optimal assignment of project managers and project managers in a multi-project based on competencies. A competency mapping was developed based on project management knowledge, project management experience, and individual project management abilities. The simulation of the model had done using CPLEX software in the AMPL language. The model developed describes the capabilities of project managers and allows them to determine their working hours and positions at any given time.

METHODOLOGY

AMPL (A Mathematical Programming Language), an algebraic modeling language to describe and solve high- complexity problems for large-scale mathematical computing (i.e., large-scale optimization and scheduling-type problems). It was developed by Robert Fourer, David Gay, and Brian Kernighan at Bell Laboratories. AMPL supports dozens of solvers, both open source and commercial software, including CBC, CPLEX, FortMP, MINOS, IPOPT, SNOPT, KNITRO, and LGO. AMPL's syntax is analogous to the mathematical notation of optimization problems, which is a benefit. This makes it possible to define optimization-related concerns in a way that is both succinct and understandable. To support re-use and simplify construction of large-scale optimization problems, AMPL allows separation of model and data.

Transportation and Assignment Problem

Transportation problem addresses the scenario where a goods are carried from

Sources to Destinations. Determining the quantity of a commodity to be delivered from each source to each destination is the goal in order to keep the overall transportation costs to a minimum. For example, steel coils are produced at three mill locations and for seven locations of vehicle plants, a total of 6,900 tons must be supplied in varying quantities to fulfil orders as shown in Fig1.

Purchase Planning problem

Purchase Planning Problem addresses the scenario where products are to be purchased from different manufacturers in order to meet the supply as well as demand requirements. For example, a textile marketing firm buys shirts from three manufacturers by considering four styles with the total order requirements to be filled as given in Fig 2.three manufacturers by considering four styles with the total order requirements to be filled as given in fig 2.

trans.mod | trans.dat

```
param: ORIGIN: supply :=
A 1400
B 2600
C 2900 ;
param: DESTIN: demand :=
KAR 900
MUM 1200
RAJ 600
HYD 400
TN 1700
UP 1100
VEL 1000 ;
param cost:
    KAR  MUM  RAJ  HYD  TN  UP  VEL :=
A    39   14   11   14  16  82    8
B    27    9   12    9  26  95   17
C    24   14   17   13  28  99   20 ;
```

Fig. 1. Data for Transportation Problem

shirt.mod | shirt.dat

```
set MANUFACTURER := M1 M2 M3;
set STYLE := S1 S2 S3 S4 ;
set FOREIGN := M1 M2;
param capacity : M1 M2 M3 :=
S1 100 80 120
S2 80 60 100
S3 75 50 75
S4 60 40 50 ;
param capacity_total := M1 275 M2 150 M3 220;
param price : M1 M2 M3 :=
S1 8 6.75 9
S2 10 10.25 10.50
S3 11 11 10.75
S4 13 14 12.75 ;
param order := S1 200 S2 150 S3 90 S4 70;
param quota:= 350;
```

Fig. 2. Data for Purchase Planning Problem

Wyndor Glass problem

Wyndor Glass problem addresses the scenario where company will be manufacturing different kinds of high-quality glass products. The glass is extracted from different plants in order to maximize the profit. The data considered is given in Fig3.

wyndor.mod | wyndor.dat

```
set PLANTS := 1 2 3;
set PRODUCTS := 1 2;
param profit :=
1   4
2   7 ;
param avail_hours :=
1       5
2      16
3      14 ;
param hours_per_batch :
        1       2 :=
1       1       2
2       1       0
3       3       2 ;
```

Fig. 3. Data for Wyndor Glass Problem

RESULTS AND DISCUSSION

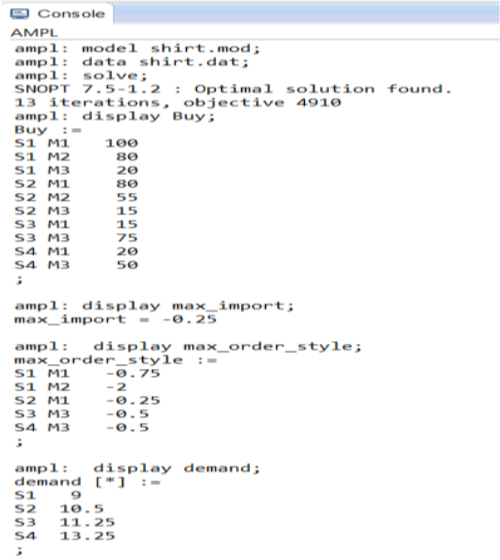
Optimal Solution is found out for the mentioned linear programming problems using AMPL.

Console

AMPL

```
ampl: model trans.mod;
ampl: data trans.dat;
ampl: solve;
SNOPT 7.5-1.2 : Optimal solution found.
15 iterations, objective 196200
ampl: display Trans;
Trans [*,*] (tr)
:       A      B      C      :=
HYD     0    400      0
KAR     0      0    900
MUM     0   1200      0
RAJ     0    600      0
TN    300      0   1400
UP   1100      0      0
VEL     0    400    600
;
```

Fig. 4. Solution for Transportation Problem



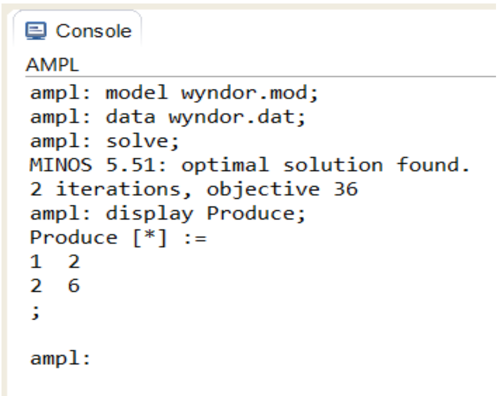
```
Console
AMPL
ampl: model shirt.mod;
ampl: data shirt.dat;
ampl: solve;
SNOPT 7.5-1.2 : Optimal solution found.
13 iterations, objective 4910
ampl: display Buy;
Buy :=
S1 M1    100
S1 M2     80
S1 M3     20
S2 M1     80
S2 M2     55
S2 M3     15
S3 M1     15
S3 M3     75
S4 M1     20
S4 M3     50
;

ampl: display max_import;
max_import = -0.25

ampl:  display max_order_style;
max_order_style :=
S1 M1    -0.75
S1 M2    -2
S2 M1    -0.25
S3 M3    -0.5
S4 M3    -0.5
;

ampl:  display demand;
demand [*] :=
S1    9
S2   10.5
S3   11.25
S4   13.25
;
```

Fig. 5. Solution for Purchase Planning Problem



```
Console
AMPL
ampl: model wyndor.mod;
ampl: data wyndor.dat;
ampl: solve;
MINOS 5.51: optimal solution found.
2 iterations, objective 36
ampl: display Produce;
Produce [*] :=
1  2
2  6
;

ampl:
```

Fig. 6. Solution for Wyndor Glass Problem

CONCLUSION

In this paper, Optimization problems of 3 kinds are solved using AMPL and the obtained results are displayed in the Console part of the AMPL software.

REFERENCES

1. A. S. Nair, P. Ranganathan and N. Kaabouch, "A constrained topological decomposition method for the next- generation smart grid," 2017 Second International Conference on Electrical, Computer and Communication Technologies (ICECCT), 2017.
2. J. Yang, J. Zhao, F. Wen and Z. Y. Dong, "A Framework of Customizing Electricity Retail Prices," in IEEE Transactions on Power Systems, vol. 33, no. 3, pp. 2415-2428, May 2018.
3. H. Ying and Z. Jiande, "A nonlinear service composition method based on the Skyline operator," in Journal of Systems Engineering and Electronics, vol. 31, no. 4, pp. 743-750, Aug. 2020.
4. M. H. Sebt, V. Shahhosseini and M. Rezaei, "Competency Based Optimized Assignment of Project Managers to Projects," 2010 12th International Conference on Computer Modelling and Simulation, 2010.
   A. C. F. Sabillón, J. F. Franco, M. J. Rider and R. Romero, "Optimal charging coordination of electric vehicles in un-balanced electrical distribution system considering vehicle-to- grid technology," 2015 3rd International Istanbul Smart Grid Congress and Fair (ICSG), 2015.
   K. Mahmoud, M. Abdel-Akher and A. -F. A. Ahmed, "Sizing and locating distributed generations for losses minimization and voltage stability improvement," 2010 IEEE International Conference on Power and Energy, 2010.
5. A. H. Dominguez, A. H. Escobar Zuluaga, L. H. Macedo and R. Romero, "Transmission network expansion planning considering HVAC/HVDC lines and technical losses," 2016 IEEE PES Transmission Distribution Conference and Exposition- Latin America (PES TD-LA), 2016

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