



Computer Science
Operations Research

Simplex Algoritm

Group 40
Professor: Francisco Torres Rojas

Carmen Hidalgo Paz
Id: 2020030538

Melissa Carvajal Charpentier
Id: 2022197088

Josué Soto González
Id: 2023207915

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1 The Simplex Algorithm

The simplex algorithm, developed by George Dantzig in 1947, arises from the need to solve linear programming problems. This problem was fundamentally proposed by Kantorovich and Koopman, who developed the optimal location problem and the problem of resources. The Simplex method optimizes an objective function subject to linear constraints, using an iterative process to improve the value of the objective function until the optimal solution is reached. Its ability to solve complex problems and its use in various applications make it an essential tool in the optimization of resources and strategic decisions in industry, economics, and operations research.

Given the time of its development, it was essentially thought to be solved by hand; however, now there are digital tools that allow the process to be automated.

1.1 George Dantzig

The American mathematician was born in 1914 and died in 2005. In addition to being the creator of the Simplex algorithm, he was head of the Scientific Computing of Operations Research (SCOOP), where he promoted linear programming for strategic purposes during World War II.



2 Problem: Test

The problem inputted by the user is called “Test” and consists of maximizing the following function:

$$Z = x_1 \cdot 300.000000 + x_2 \cdot 200.000000$$

Subject to:

$$\begin{aligned}x_1 \cdot 0.025000 + x_2 \cdot 0.016667 &\leq 1.000000 \\x_1 \cdot 0.020000 + x_2 \cdot 0.020000 &\leq 1.000000 \\x_1 \cdot 1.000000 + x_2 \cdot 0.000000 &\geq 30.000000 \\x_1 \cdot 0.000000 + x_2 \cdot 1.000000 &\geq 20.000000\end{aligned}$$

3 Initial Matrix with M cost

Z	x1	x2	s1	s2	e1	e2	a1	a2	b
1.000	-300.000	-200.000	0.000	0.000	0.000	0.000	0.000 + 1.0M	0.000 + 1.0M	0.000
0.000	0.025	0.017	1.000	0.000	0.000	0.000	0.000	0.000	1.000
0.000	0.020	0.020	0.000	1.000	0.000	0.000	0.000	0.000	1.000
0.000	1.000	0.000	0.000	0.000	-1.000	0.000	1.000	0.000	30.000
0.000	0.000	1.000	0.000	0.000	0.000	-1.000	0.000	1.000	20.000

4 Initial Normalized Matrix

Z	x1	x2	s1	s2	e1	e2	a1	a2	b
1.000	-300.000 + -1.0M	-200.000 + -1.0M	0.000	0.000	0.000 + 1.0M	0.000 + 1.0M	0.000	0.000	0.000 + -50.0M
0.000	0.025	0.017	1.000	0.000	0.000	0.000	0.000	0.000	1.000
0.000	0.020	0.020	0.000	1.000	0.000	0.000	0.000	0.000	1.000
0.000	1.000	0.000	0.000	0.000	-1.000	0.000	1.000	0.000	30.000
0.000	0.000	1.000	0.000	0.000	0.000	-1.000	0.000	1.000	20.000

5 Intermediate Matrixes

The intermediate tables are shown below. A column is added to show the fractions of each row. The selected column to enter the basis is colored in pink while the pivot and selected fraction value are colored in a darker shade of pink.

5.1 Pivot Table

Z	x1	x2	s1	s2	e1	e2	a1	a2	b	Fractions
1.000	0.000	-200.000 + -1.0M	0.000	0.000	-300.000	0.000 + 1.0M	300.000 + 1.0M	0.000	9000.000 + -20.0M	
0.000	0.000	0.017	1.000	0.000	0.025	0.000	-0.025	0.000	0.250	40.000
0.000	0.000	0.020	0.000	1.000	0.020	0.000	-0.020	0.000	0.400	50.000
0.000	1.000	0.000	0.000	0.000	-1.000	0.000	1.000	0.000	30.000	30.000
0.000	0.000	1.000	0.000	0.000	0.000	-1.000	0.000	1.000	20.000	Invalid

5.2 Pivot Table

Z	x1	x2	s1	s2	e1	e2	a1	a2	b	Fractions
1.000	0.000	0.000	12000.000 + 60.0M	0.000	0.000 + 1.5M	0.000 + 1.0M	0.000 + -0.5M	0.000	12000.000 + -5.0M	
0.000	0.000	1.000	60.000	0.000	1.500	0.000	-1.500	0.000	15.000	15.000
0.000	0.000	0.000	-1.200	1.000	-0.010	0.000	0.010	0.000	0.100	20.000
0.000	1.000	0.000	0.000	0.000	-1.000	0.000	1.000	0.000	30.000	Invalid
0.000	0.000	0.000	-60.000	0.000	-1.500	-1.000	1.500	1.000	5.000	20.000

6 Result Analysis

6.1 Non feasible problems

Sometimes the simplex algorithm may be faced with a non feasible problem, as a result of the model. In the simplex table thid is represented by coefficients of M different than zero in the first row

Z	x1	x2	s1	s2	e1	e2	a1	a2	b
1.000	0.000	0.000	12000.000 + 60.0M	0.000	0.000 + 1.5M	0.000 + 1.0M	0.000 + -0.5M	0.000	12000.000 + -5.0M
0.000	0.000	1.000	60.000	0.000	1.500	0.000	-1.500	0.000	15.000
0.000	0.000	0.000	-1.200	1.000	-0.010	0.000	0.010	0.000	0.100
0.000	1.000	0.000	0.000	0.000	-1.000	0.000	1.000	0.000	30.000
0.000	0.000	0.000	-60.000	0.000	-1.500	-1.000	1.500	1.000	5.000