P’polom

Authors

Ricardo Iván Valencia González

Abstract

P’polom is a solution model to find the best conditions to import products into México, taking into consideration the foreign trade process and Mexican legislation. Solved using «Darwin» an implementation for Genetic Algorithms; GA helps solve this multivariate optimization problem

Keywords

Genetic algorithm. Multivariate Optimization. Stochastic Search. Foreign Trade. External commerce.

Introduction

«Vivimos en una sociedad globalizada, donde ya no estamos tan lejos los unos de los otros» –Julia Navarro

Today, one of the most important factors of globalization is foreign trade. Thanks to this, we have been able not only to meet the needs of people around the world, but their quality of life has increased significantly. Trade is considered an art that has been perfected over the centuries, but remains a long, complicated process and definitely not everyone can understand. Constantly changing laws, treaties and agreements impedes making accurate and fast decisions both for companies and for individuals. This solution model poses an automated method in which to be able to compare your options and decide in an informed, fast and accurate way to choose the best conditions to import a product into México.

State of the Art

Optimization models have been a success on many areas, both for theoretical purposes as well as a reliable tool on fields as diverse as manufacturing, medicine, transportation, stock market, among many others. One of the key advantages of using Evolutionary Techniques is their natural capacity to deal with the problem of local solutions for problems with a wider scope, non-linear solutions and multivariate optimization functions (Simon & Sean, 1999). Genetic Algorithms (GA) use the concept of stochastic search developing population of possible solutions instead of the classic “one solution at a time” approach of other optimization models (Amouzgar, 2012).

No other model to optimize conditions on foreign trade case was found, so it is a relatively new area of development, even if it fits into some common models, such as the mentioned Stochastic Search and Multivariate Optimization.

Proposal

This project aims to propose a model for an evolutive approach to get the best set of conditions to import a product to México. Given the number of variables that must be taken into account, the analysis easily grows in complexity, so an evolutive algorithm offers a reduction on complexity and a model that's easy to modify to optimize performance, or even to change the way those optimal conditions are met.

Development

To make this a self-contained, manageable project, an in-house GA framework was developed, named «Darwin», using Python. It uses a standard Crossover Operation, a Rank Selector for the next generation's parent selection. A Mutation Operation is also defined that mutates a portion of the population. «Darwin» can solve both maximization and minimization problems and records the whole evolution for further analysis. The setup is simple: define labels and a list of possible values for each label; a fitness function and general configuration for the GA (population size, crossover rate, mutation rate, number of generations). After these configuration is done «Darwin» follow the same flow as other GA:

- Create a population of random solutions
- Calculate fitness value
- Select parents for next generation
- Apply the crossover operation
- Apply the mutation operation

P'polom is then an implementation using «Darwin» and a specific set of variables and a special fitness function. A specific product is chosen and used for each run of P'polom; the only two variables «Darwin» evolves are the selection of a country to import from, and the number of "units" to import (a generic unit is used because some products are measured by piece, kg, liter or even heads, for living animals). A separate set of data is loaded from JSON files that will be used on the fitness function evaluation. This JSON files contain: information of distances between countries and México, information of all the Foreign Trade Agreements (FTA) México has signed and the corresponding tax reduction on some products, a list of import quota for the product set. All this is then used for the fitness function, giving a unified numeric value using all the information from the JSON files explained before. This numeric value is then calculated as follows:

Given the country (c):

- Get distance to that country (*dist*)
- If México has a FTA with that country:
    - Get tax discount (*trade_t*) for the selected product

Given the units (u):

- Get regular import tax for that product (*regular_t*)
- Calculate difference between the units and the product's import quota (*q_delta*)

If the country has a tax discount, replace *regular_t* with *trade_t* as *tax*.

$$f(c,u) = dist + q\_delta + (tax * q\_delta)$$

This formula does not represent a measurable value in terms of money but rather a specific metric for this project.

To run P'polom, the only requirement is the numpy package for Python, used for statistical analysis of the last generation.

Results

In general, P'polom does a decent job finding the best set of conditions to select a country candidate for import. Tested on a series of scenarios that mimics real life possibilities of an FTA and a discount, a fixed quota for a product and the relative flight distance. After evolving the initial population, P'polom can accurately pick a country who has an FTA with México, and in case of being many countries, it selects the closest one and the one offering the best tax discount for the given product.

For an example run, the next configuration was used:

Population size	200
Crossover rate	0.6
Mutation rate	0.02
Generations	500

With product 1001.90.01 which is the Harmonized System code for Wheat, this resulted on:

Country	Guatemala
Units	7,000
Fitness for best individual	477059
Avg fitness last generation	477059

Wheat has the same tax discount for all countries with a FTA, but P'polom choses a near country, so Guatemala was selected as best option. Both fitness for best individual and the avg fitness are the same because the last generation had no other different chromosome, this is, the GA converged into this result before finishing to evolve all generations.

Another test run with product 1005.90.03, White or Yellow Corn, using the same configuration as before, got the results:

Country	United States
Units	2,000
Fitness for best individual	393024
Avg fitness last generation	393024

This is a good example of mixing both quotas, FTA and distances. Because is an important product for Mexican economy, Corn has a high tax for import: 194. On top of that, corn from Peru has an annual quota of 90'718,474 kg; countries part of the «Centro América Trade Agreement» has quota of 108'862,169 kg. So, because the quota limitations, none of those countries offer a really good choice, so United States becomes the next best option: near enough and no quota limit.

Final Words

Darwin is the first and clear area of opportunity, as it was developed on a time constraint. A Wheel Selector is coded but it's not fully working so it was not used for P'polom. Also, a more formal comparison of configurations performance may help to improve the general solution for this problem. The mutation model can be adjusted for better performance into finding a right solution and as mentioned, the Selection operation can be changed or modified; a comparison is needed to decide this.

Some troubles arise when selecting products with no quota, because the algorithms nature minimizes the number of units to import; this can be solved either defining a default quota or a minimum desired product quantity for a specific company or market. All this can be made on the «Darwin» configuration.

P'polom and in general this problem has difficulties gathering the relevant data, because the Mexican legislation is changing all the time and there is not (or at least is was not found) a reliable source of information; most of the data used on this project was on JSON files built by hand. Because of this, some simplification on import taxes and product selection was done to reduce the scope of the project. A real tool based on this model should include all products from the Harmonized System.

The full code can be found at the public repository: https://github.com/avatharBot/ppolom. It is released under MIT License

References

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