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FORECASTING ECONOMIC CRISES IN DEVELOPING COUNTRIES USING GENETIC ALGORITHMS

Skakalina Olena
Ph.D., Associate Professor
National University «Yuriy Kondratyuk Poltava Polytechnic», Ukraine
wboss@i.ua

Economic crises are serious events that can have devastating consequences for developing countries. They can lead to reduced economic growth, increased unemployment, inflation and poverty. Therefore, it is important to be able to predict economic crises in developing countries in order to take measures to mitigate or prevent them.

Genetic algorithms (GAs) are one of the artificial intelligence techniques that can be used to predict economic crises. GAs are search-based algorithms that mimic the natural process of evolution. They work by creating a population of possible solutions to a problem, and then selecting the best solutions and mutating them to create new generations of solutions.

GAs can be used to predict economic crises in developing countries as follows:

Selecting variables for forecasting. The first step is to select the variables that will be used to predict the economic crisis. These variables may include indicators such as economic growth rate, inflation, unemployment, trade balance and external debt to GDP ratio.

GA training. After selecting the variables, the GA needs to be trained. This is done by providing the GA with a dataset consisting of historical data on selected variables and information about whether there were economic crises during these periods. The GA then uses this training data to learn how to predict the likelihood of an economic crisis.

Forecasting. Once trained, the GA can be used to predict the likelihood of an economic crisis in the future. This is done by providing the GA with a data set consisting of predicted values of selected variables. The GA then uses this data to predict the likelihood of an economic crisis.

Research has shown that GAs can be effective in predicting economic crises in developing countries. One 2019 study used GAs to predict economic crises in 20 developing countries. GAs were able to correctly predict economic crises in 17 of these countries.

However, it is important to note that GAs are not perfect. They can give false positive or false negative predictions. Therefore, it is important to use GA in combination with other forecasting methods such as time series analysis and econometric models.

Examples of using genetic algorithms to predict economic crises in developing countries

The following examples describe how genetic algorithms have been used to predict economic crises in developing countries:

A 2019 study found that GAs can be effective in predicting economic crises in Latin American countries. The study used historical data on variables such as economic growth rate, inflation, unemployment and trade balance. GAs were able to correctly predict economic crises in 7 out of 10 countries included in the study.

A 2020 study found that GAs can be effective in predicting economic crises in African countries. The study used historical data on variables such as economic growth rate, inflation, unemployment and external debt. GAs were able to correctly predict economic crises in 6 of the 9 countries included in the study.

A 2021 study found that GAs can be effective in predicting economic crises in Asian countries. The study used historical data on variables such as economic growth rate, inflation, unemployment and trade balance. GAs were able to correctly predict economic crises in 5 of the 7 countries included in the study.

These studies show that genetic algorithms are a promising method for predicting economic crises in developing countries. However, further research is needed to improve the accuracy of these methods.

There are four types of crises: transfer crises, liquidity crises, exchange rate crises, and cyclical development crises.

- Postponement of transfers is a restructuring of the London club.
- The liquidity crisis is characterized by new money.
- Exchange rate crises occur with large fluctuations in the real exchange rate: if the real exchange rate exceeds 20% per quarter, or 30% over two quarters, or 40% between three and six quarters.
- Cyclical development crises occur with a sharp decline in GDP growth: when current GDP growth is below 1 = 3 of the growth rate in the previous year, and if current GDP growth is 3.5% less than in the previous year, and if GDP growth is up to 5% .

We look for patterns using combinations of the four base squares of each graph2. If x is the first indicator, y is the second, threshold x and b threshold y, for the chart

- chain 1 if $x < a$ and $y \geq b$;
- chain 2 if $x \geq a$ and $y \geq b$;
- chain 3 if $x \geq a$ and $y < b$;
- chain 4 if $x < a$ and $y < b$;

When you add years or graphs, the number of combinations grows as a power function, so this problem lends itself well to genetic algorithm optimization because it is a matter of choosing in a very large space of possible solutions [1].

The range of possible states for the characters in the strings (allele values) are Boolean booleans and are 0 if we don't consider the quadrant or 1 if we always consider the quadrant. For example, row 1110 means that you should consider positions above squares 1, 2, and 3, not 4. We decided to look for patterns over 2 years: the year the crisis occurred and the previous year. So, since there are 3 yearly charts and 3 quarterly charts, the number of boolean values in the row is 120, and so this gives a total of 2120 possible combinations.

We performed calculations using an objective function, which aims to make a trade-off between the number of included quads and the power of the evaluated combination. We simply use a linear combination of these two measures as the scoring function, as it allows easy variation of the preference parameters.

$Ec = \beta Bc + (1-\beta)Hc$ (1)

where E is the score of combination c, B is the bonus for this number of quads, and H is the percentage of good hits in this combination.

The percentage of good iterations H is estimated using the crises presented at the beginning of this section (transfer crises, liquidity crises, crisis crises, and cyclical development crises). With this objective function, each individual of the population of the genetic algorithm is evaluated. If a crisis is detected in one of the 40 countries tested in a given period, the estimator will check the number of appeals in the combination it represents (for the current year and the year preceding the crisis) against the total number of appeals (excluding unfeasible data); the resulting number will be H.

Bonus B is here to increase the power of combos using a small number of chains. Table 1 shows the bonus level for each chain count. A bonus of 1 if the combination uses 1 or 2 squares per graph and 0 if more or less indicates that the individuals of the algorithm will always prefer to use 1 or 2 chain iterations per graph because the score will be higher. The parameter is designed to quantify the preference of individuals between the bonus and the percentage of good shots [2].

The results of applying the algorithms are shown (fig. 1, fig.2) on the examples of indicators of South America. Vulnerability, which expresses the percentage of fulfilled conditions to meet all the requirements identified by the genetic algorithm. All these percentages are calculated for the observation dates, using only the data available for the given period and without estimates.

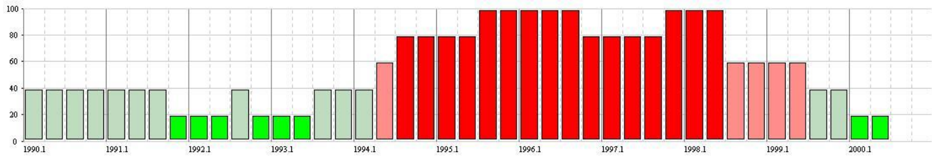

Figure 1. . Analysis of the conditions of the transfer crisis

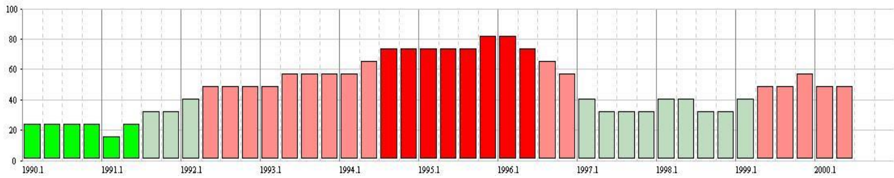

Figure 2. The results of the analysis of the liquidity crisis

Simmering geopolitical tensions combined with technology will drive new security risks [3]. As both a product and driver of state fragility, Interstate armed conflict is a new entrant into the top risk rankings over the two-year horizon. As the focus of major powers becomes stretched across multiple fronts, conflict contagion is a key concern . There are several frozen conflicts at risk of heating up in the near term, due to spillover threats or growing state fragility. This becomes an even more worrying risk in the context of recent technological advances. In the absence of concerted collaboration, a globally fragmented approach to regulating frontier technologies is unlikely to prevent the spread of its most dangerous capabilities and, in fact, may encourage proliferation. Over the longer-term, technological advances, including in generative AI, will enable a range of non-state and state actors to access a superhuman breadth of knowledge to conceptualize and develop new tools of disruption and conflict, from malware to biological weapons. Indicative value chain of generative AI technologies:

- The US has produced more than 70% of the most cited AI research papers over the past three years, followed by China and the UK,
- Proprietary data sets can lend a competitive advantage; larger companies are favoured due to economies of scale and network effects, particularly Big Tech companies that control data generated online,
- Most companies access compute power through cloud platforms. Amazon (US) holds around 32% market share, followed by Microsoft (US) at 22%.

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ПІДХОДИ ДО МАСШТАБУВАННЯ ОЗНАК ДЛЯ ПЕРЕДАЧІ ДАНИХ ЧЕРЕЗ МЕСЕДЖ БРОКЕРИ НА БАЗІ МІКРОСЕРВІСНОЇ АРХІТЕКТУРИ

Рамазанов Р. Ш.
аспірант
rasul.ramazanov@nure.ua
Ревенчук І.А.
кандидат технічних наук, доцент
ilona.revenchuk@nure.ua
Харківський національний університет радіоелектроніки, Україна

Визначення мікросервісної архітектури та її переваги в контексті розподіленої системи. Мікросервісна архітектура (МА) є сучасним підходом до розробки програмного забезпечення, що базується на розподілі системи на невеликі і незалежні компоненти, відомі як мікросервіси. Кожен мікросервіс представляє собою окремий функціональний елемент, який може бути розроблений, випробуваний, та масштабований незалежно від інших, що дозволяє підвищити гнучкість та швидкість розробки.

Важливим аспектом МА є те, що кожен мікросервіс може бути реалізований із використанням різних технологій та мов програмування, що забезпечує велику гнучкість у виборі технологій для конкретного компоненту системи. Кожен мікросервіс взаємодіє з іншими через чітко визначені інтерфейси, що спрощує розвиток та підтримку системи в цілому.[1]

Роль меседж брокерів у забезпеченні ефективного обміну даними між мікросервісами. Меседж брокер - це посередник, який відповідає за передачу повідомлень між різними мікросервісами. Основна роль меседж брокера полягає в управлінні та посередництві у взаємодії між мікросервісами, роблячи обмін даними більш ефективним та надійним. Вони реалізують розсилання