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APPLICATIONS OF GENETIC ALGORITHMS IN GDP FORECASTING

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***Abstract*— Gross domestic product (GDP) is the market value of all officially recognized final goods and services produced within a country in a given period of time. GDP per capita is often considered an indicator of a country's standard of living; GDP per capita is not a measure of personal income.In today's Economy Driven world, every country wants to keep its GDP rate as high as possible, to maintain its position among various other countries. To keep the rating high the country needs to do more and more development, and in this way they provide a better living to their citizens.A system to forecast the GDP of a company in a given period of time is a good idea, as it will prove beneficial to the countries, by letting them know in which area to invest more and when.**

***Index Terms*—Component, formatting, style, styling, insert.** *(key words)*

I. INTRODUCTION.

The paper explores the application of Human Genetic System of Human Beings to the problem of forecasting the GDO of a nation, well in advance. It aims at building a system for the correct prediction of the GDP of a nation in advance, providing ease to the country. The aim is to build a system based on the ideas inspired by the HGS, to calculate the investments and earnings of a country and thus creating result based on this, about the possible GDP.

The system is useful for everyone, to the countries as they will come to know well in advance where to invest more and when, also they will come to know where to improve so as to increase earnings. To the Financial Agencies it is useful as they can predict the GDP of a country over a time and can suggest the investments to other parties.

The system will work by collecting various information about the economy of the country, the variable factors which can affect the calculation at a later stage or instantaneously somewhere.

A. Challenges

Our challenge is thus to:

1. Design a self-organized; GA based GDP Prediction System (GDPPS).
2. Deal with the changing economic conditions.
3. Deal with dynamic class imbalances and Concept drift.
4. Understand how a decentralized GA based system can achieve GDP Prediction.
5. To train the system once in the beginning for adaptive learning.
6. Collect all the required values to calculate.

II. LITERATURE REVIEW

A. Genetic Algorithm

In the computer science field of artificial intelligence, a genetic algorithm (GA) is a search heuristic that mimics the process of natural evolution. This heuristic is routinely used to generate useful solutions to optimization and search problems. Genetic algorithms belong to the larger class of evolutionary algorithms (EA), which generate solutions to optimization problems using techniques inspired by natural evolution, such as inheritance, mutation, selection, and crossover.

1) Methodologies

In a genetic algorithm, a population of candidate solutions (called individuals, creatures, or phenotypes) to an optimization problem is evolved toward better solutions. Each candidate solution has a set of properties (its chromosomes or genotype) which can be mutated and altered; traditionally, solutions are represented in binary as strings of 0s and 1s, but other encodings are also possible.

The evolution usually starts from a population of randomly generated individuals and happens in generations. In each generation, the fitness of every individual in the population is evaluated, the more fit individuals are stochastically selected from the current population, and each individual's genome is modified (recombined and possibly randomly mutated) to form a new population. The new population is then used in the next iteration of the algorithm. Commonly, the algorithm terminates when either a maximum number of generations has been produced, or a satisfactory fitness level has been reached for the population.

A typical genetic algorithm requires:

1. a genetic representation of the solution domain,
2. a fitness function to evaluate the solution domain.

A standard representation of each candidate solution is as an array of bits. Arrays of other types and structures can be

used in essentially the same way. The main property that makes these genetic representations convenient is that their parts are easily aligned due to their fixed size, which facilitates simple crossover operations. Variable length representations may also be used, but crossover implementation is more complex in this case. Tree-like representations are explored in genetic programming and graph-form representations are explored in evolutionary programming; a mix of both linear chromosomes and trees is explored in gene expression programming.

Once the genetic representation and the fitness function are defined, a GA proceeds to initialize a population of solutions and then to improve it through repetitive application of the mutation, crossover, inversion and selection operators.

2) Limitations

I. Repeated fitness function evaluation for complex problems is often the most prohibitive and limiting segment of artificial evolutionary algorithms. Finding the optimal solution to complex high dimensional, multimodal problems often requires very expensive fitness function evaluations.

II. Genetic algorithms do not scale well with complexity. That is, where the number of elements which are exposed to mutation is large there is often an exponential increase in search space size. This makes it extremely difficult to use the technique on problems such as designing an engine, a house or plane.

III. The "better" solution is only in comparison to other solutions. As a result, the stop criterion is not clear in every problem.

IV. In many problems, GAs may have a tendency to converge towards local optima or even arbitrary points rather than the global optimum of the problem. This means that it does not "know how" to sacrifice short-term fitness to gain longer-term fitness.

V. Operating on dynamic data sets is difficult, as genomes begin to converge early on towards solutions which may no longer be valid for later data.

VI. GAs cannot effectively solve problems in which the only fitness measure is a single right/wrong measure, as there is no way to converge on the solution (no hill to climb). In these cases, a random search may find a solution as quickly as a GA. However, if the situation allows the success/failure trial to be repeated giving (possibly) different results, then the ratio of successes to failures provides a suitable fitness measure.

VII. For specific optimization problems and problem instances, other optimization algorithms may find better solutions than genetic algorithms. Alternative and complementary algorithms include evolution strategies, evolutionary programming, simulated annealing, Gaussian adaptation, hill climbing, and swarm intelligence and methods based on integer linear programming.

3) Applications

a) Finance & Investment Strategies

In the current unprecedented world economic meltdown one might legitimately wonder if some of those Wall Street gamblers made use of GA-assisted computer modelling of finance and investment strategies to funnel the world's accumulated wealth into what can best be described as dot-dollar black holes. But then again, maybe they were simply all using the same prototype, which hadn't yet been de-bugged. It is possible that a newer generation of GA-assisted financial forecasting would have avoided the black holes and returned something other than bad debts the taxpayers get to repay. Who knows?

B. GDP

GDP was first developed by Simon Kuznets for a US Congress report in 1934. In this report, Kuznets warned against its use as a measure of welfare. After the Bretton Woods conference in 1944, GDP became the main tool for measuring a country's economy.

Gross domestic product (GDP) is the market value of all officially recognized final goods and services produced within a country in a given period of time. GDP per capita is often considered an indicator of a country's standard of living; GDP per capita is not a measure of personal income. Under economic theory, GDP per capita exactly equals the gross domestic income (GDI) per capita.

GDP is related to national accounts, a subject in macroeconomics. GDP is not to be confused with gross national product (GNP) which allocates production based on ownership.

1) Determining GDP

GDP can be determined in three ways, all of which should, in principle, give the same result. They are:

i. The Product Approach
ii. The Income Approach
iii. The Expenditure Approach

The most direct of the three is the product approach, which sums the outputs of every class of enterprise to arrive at the total. The expenditure approach works on the principle that all of the product must be bought by somebody, therefore the value of the total product must be equal to people's total expenditures in buying things. The income approach works on the principle that the incomes of the productive factors ("producers," colloquially) must be equal to the value of their product, and determines GDP by finding the sum of all producers' incomes.

a) Production Approach

"Market value of all final goods and services calculated during 1 year."

The production approach is also called as Net Product or Value added method. This method consists of three stages:

1. Estimating the Gross Value of domestic Output in various economic activities;

2. Determining the intermediate consumption, i.e., the cost of material, supplies and services used to produce final goods or services; and finally
3. Deducting intermediate consumption from Gross Value to obtain the Net Value of Domestic Output.

Fig.1 GDP growth

$GDP = \text{private consumption} + \text{gross investment} + \text{government spending} + (\text{exports} - \text{imports})$, or

$$GDP = C + I + G + (X - M)$$

2) Income Approach

"Sum total of incomes of individuals living in a country during 1 year."

Another way of measuring GDP is to measure total income. If GDP is calculated this way it is sometimes called Gross Domestic Income (GDI), or GDP(I). GDI should provide the same amount as the expenditure method described below. (By definition, GDI = GDP. In practice, however, measurement errors will make the two figures slightly off when reported by national statistical agencies.)

This method measures GDP by adding incomes that firms pay households for factors of production they hire- wages for labour, interest for capital, rent for land and profits for entrepreneurship.

Two adjustments must be made to get GDP:

1. Indirect taxes minus subsidies are added to get from factor cost to market prices.
2. Depreciation (or Capital Consumption Allowance) is added to get from net domestic product to gross domestic product.

$GDP = \text{compensation of employees} + \text{gross operating surplus} + \text{gross mixed income} + \text{taxes less subsidies on production and imports}$

$$GDP = COE + GOS + GMI + T_{P\&M} - S_{P\&M}$$

3) Expenditure Approach

"All expenditure incurred by individuals during 1 year."

In economics, most things produced are produced for sale, and sold. Therefore, measuring the total expenditure of money used to buy things is a way of measuring production. This is known as the expenditure method of calculating GDP. Note that if you knit yourself a sweater, it is production but does not get counted as GDP because it is never sold. Sweater-knitting is a small part of the economy, but if one counts some major activities such as child-rearing (generally unpaid) as production, GDP ceases to be an accurate indicator of production. Similarly, if there is a long term shift from non-market provision of services (for example cooking, cleaning, child rearing, do-it yourself repairs) to market provision of services, then this trend toward increased market provision of services may mask a dramatic decrease in actual domestic production, resulting in overly optimistic and inflated reported GDP. This is particularly a problem for economies which have shifted from production economies to service economies.

GDP (Y) is a sum of Consumption (C), Investment (I), Government Spending (G) and Net Exports (X – M).

$$Y = C + I + G + (X - M)$$

III. The Application: Forecasting GDP of a Country

Given a collection of data pertaining to a country's economy, the task is to predict the future performance of that country's GDP. Specifically, we predict the GDP of a country over 12 months or approximately one calendar year into the future. Relative GDP is computed with respect to a particular index, a weighted average of GDP for similar time period.

A. Procedure

GDP of any country is calculated by any of the three methods mentioned. We need to get all the required values for the calculation of GDP, a database is maintained storing all the required fields for the calculation of GDP of previous years. The application will compare the present conditions with the older values stored in the database and the variable conditions affecting the values in present, and will generate the output as a prediction of the GDP of the specific country for a particular time period.

The application will predict the values of the required filed according to the prevailing trends and the current market position. The algorithm will keep a watch on all the investments and policies taking place in the country and their effect in the near or far future, learning from the previous incidents.

For this purpose we need to get all the required information from the concerned country and keep a close watch on all the

economic activities taking place in that financial year, plus also all the activities to be kept in watch which may affect the economy of the country.

B. Requirements

I. Database to store all the values.
II. AI agent to analyse the situations.
III. Algorithm to work on the given values.
IV. Specialists to feed in the manual values.
V. User agent to handle the required computation.

C. Example

Indian GDP is calculated according to the Expenditure methods, which are, Sum of Consumption, Investment, Government Spending and Net Export

1) Facts of Indian GDP

I. Indian Economy is the 10th largest in the world.
II. It ranks 5th pertaining to Purchasing Power Parity (PPP) according to the latest calculation of the World Bank.
III. GDP of India in the year 2007 was US $1.07 trillion.
IV. The growth rate of Indian GDP was 9.4% per year.
V. GDP of India in 2011 was US $1847.98 billion.
VI. GDP value of India represents 2.98% of World Economy.

2) Points to remember while calculating Indian GDP

I. Calculating Indian GDP has to be done cautiously pertaining to the diversity of Indian Economy.
II. There are different sectors contributing to the GDP of India, such as, Agriculture, Textile, Manufacturing, Information Technology, Tele-communication, Petroleum, etc.
III. Different sectors contributing to the Indian GDP are classified into 3 segments:
a) Primary or Agriculture sector.
b) Secondary or Manufacturing sector.
c) Tertiary or Service sector.
IV. India has become one of the most famous destinations for outsourcing activities.
IV. India at present is one of the biggest exporters of highly skilled labour to the world.

3) Method to calculate GDP {GDP = C + I + G + (X-M)}

Here is a description of each GDP component:

- C (consumption) which includes personal expenditures pertaining to food, households, medical expenses, rent, etc.
- I (investment) includes, for instance, business investment in equipment, but does not include exchanges of existing assets. Examples include construction of a new mine, purchase of software, or purchase of machinery and equipment for a factory, purchase of software, expenditure on new house, buying goods and services, but investment on financial product is not included as it falls under savings.
- G (government spending) is the sum of government expenditures on final goods and services. It includes salaries of public servants, purchase of weapons for the military, and any investment expenditure by a government. It does not include any transfer payments, such as social security or unemployment benefits.
- X (exports) represents gross exports. GDP captures the amount a country produces, including goods and services produced for other nations' consumption, therefore exports are added.
- M (imports) represents gross imports. Imports are subtracted since imported goods will be included in the terms G, I, or C, and must be deducted to avoid counting foreign supply as domestic.

V. Future Work

The proposed system needs a lot of working to be done in future, including the development of an algorithm for the solution of this purpose and conducting real life experiments to get the results and to check the concept, whether it is correctly working or not.

Major points of the future work include:

- Development of the algorithm.
- Development of a user agent.
- Conducting theoretical experiments.
- Conducting real life practical experiments.
- Creating a working model.
- Testing the model on various conditions.

VI. Conclusion

This article has presented a new genetic-algorithm-based system for inductive machine learning. The system is applied to financial forecasting, specifically to predicting the GDP of a country. There are many other GA based systems available in the market for forecasting various other things like, weather, stocks, etc. We propose a GA based system to forecast the GDP of a country, by using adaptive learning techniques of GA, by providing the system with all the inputs required and getting back the best possible prediction in the form of result.

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