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SCAN ME

Research Question

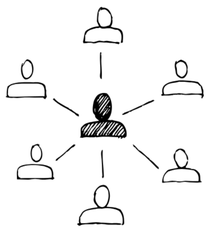
How should Calculus models be utilized in startups to improve economic decision making and overall financial health?

Problem Statement

There is an obscenely large gap of the implementation of calculus into equations to improve a small, financially strained business's financial health. The goal is to improve a business's access to accurate prediction based equations derived from past data to improve financial decision making, leading to wiser choices allowing more startups to survive

Objectives

Specific goals include: successfully compiling data from the securities exchange commission, making the data understandable so it can be easily cross referenced and tested against existing equations, analyze existing equations and find their downfalls, create generalizations with the SEC Data, and cross reference the data with the newly implemented calculus equations.
These equations will be embedded in a user friendly website, so anyone can plug in their financial data and get their business's financial predictions.



Target Audience: Small business owners looking to scale their business

Methodology

Case Study

-Analyze existing models of calculus in business (IE: Black -Scholes equation used in option trading
-Reverse engineer methodology used to develop those equations

Data Collection

-Gather financial data from securities and exchange commission
-Compile data into txt docs for analysis

Model Development

-Analyze the Data from the SEC using multiple trend analysis tools such as openlogic
-Create calculus models that accurately reflect the tredns in the SEC data

Results

The data collection process has been widely successful. Models that were analyzed include the Inventory and Demand Dynamics model

$$\frac{dI}{dt} = f(D(t), I(t)) = kD(t) - \mu I(t)$$

the ARIMA with Continuous Time (Integral Form)

$$S(t) = \int_0^\infty e^{-\alpha\tau}[\beta S(t-\tau) + \gamma\epsilon(t-\tau)]d\tau,$$

and a few others. After reverse-engineering the calculus equations, I created a web scraper bot to compile data from the Securities and Exchange Commission. This was largely successful, and I was able to collect the financial data of all companies in the first and second quarters of 2024. After compiling the data, I set out to improve algebraic equations. Using the notes I took on the derivations of the calculus models during the case study, I improved existing equations.

Name	Original Equations	New Equations
Sales Prediction with Time-Varying Advertising Impact	$\sum_{\tau=0}^{t} A_\tau \alpha^{t-\tau}$	$S(t) = S_0 + \int_0^t k\,A(\tau)\,e^{-\lambda(t-\tau)}\,d\tau,$
Compound Interest ROC	$D = \frac{C-S}{L}$	$V(t) = V_0 e^{-\lambda t}$
Straight Line Depreciation	$PV = \sum_{t=1}^{N} \frac{CF_t}{(1+r)^t}$	$PV = \int_0^T CF(t)\,e^{-rt}\,dt$

Limitations

though these models represent a substantial improvement over previous algebra-based models, there are a few fundamental flaws inherent in calculus itself. This model cannot effectively analyze data from a short period of time. For example, suppose Bob earns $10,000 in his monthly paycheck. If data from a single day is input into the model, it will assume that Bob earned $10,000 in one day because it is only analyzing the rate of change without considering the historical context. Consequently, the model will output a result much higher than the actual number, as it will assume Bob earns $10,000 per day instead of $10,000 per month.

Improvements

I found that when cross-referenced with SEC data, the new calculus-based equations are approximately 7% more accurate than the original equations. This is a huge leap, as businesses can predict their numbers with 7% more accuracy, allowing them to save a ton of money.

Conclusion

This project has been mind-opening to the benefits of calculus in business prediction models. The calculus models showed, on average, a 7% improvement over the previously widely used algebraic models (data compared with the same subsets in 2024 Q1 and Q2, outliers removed). These models aren't too complex to comprehend, as they use some of the same variables found in the algebraic-based equations, allowing businesses using the old equations to easily transition to the new equations.

Next Steps

There is still much to be uncovered in the business applications of calculus. Many more existing algebraic equations can be converted into more efficient and effective calculus equations, and there has yet to be an intuitive and simple platform that hosts all these equations with an easy-to-use median. The next step would be to create a user-friendly website where even business owners with no prior experience in calculus can input their numbers and receive an accurate estimated output.

Citations

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