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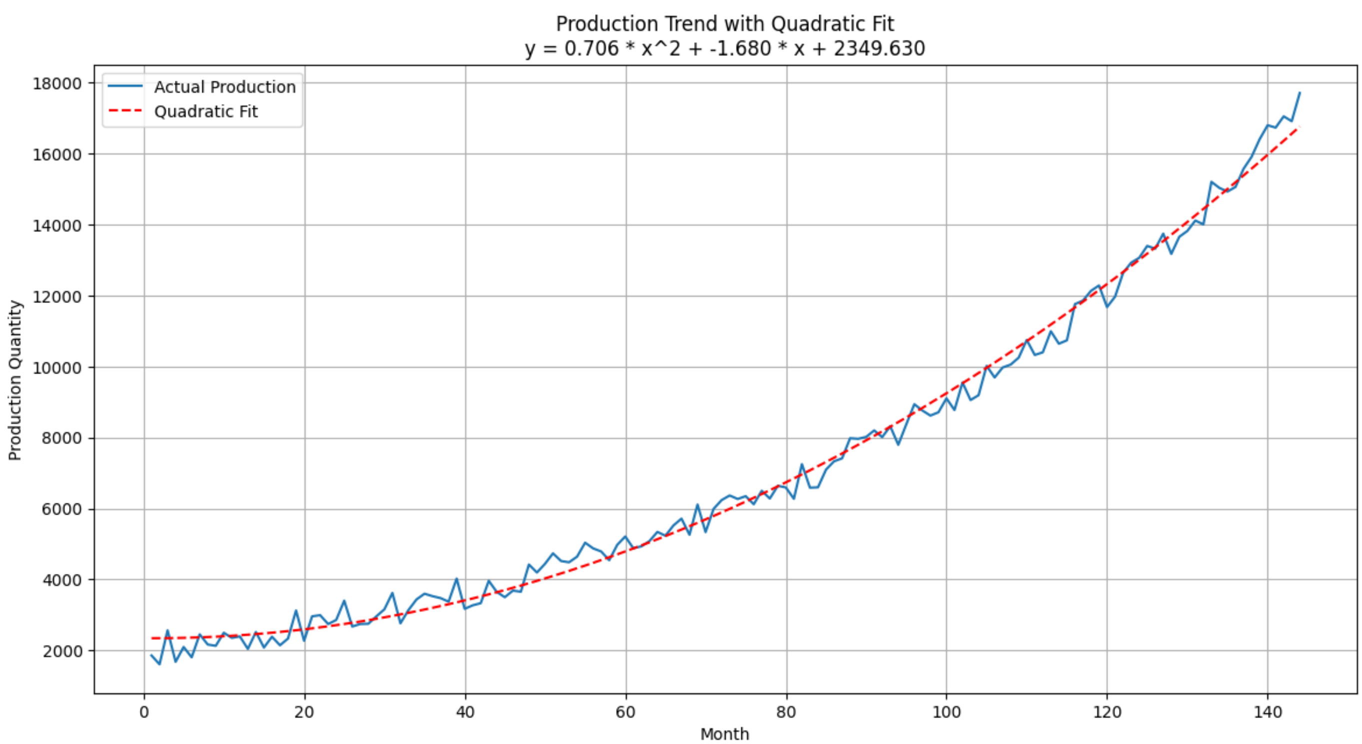
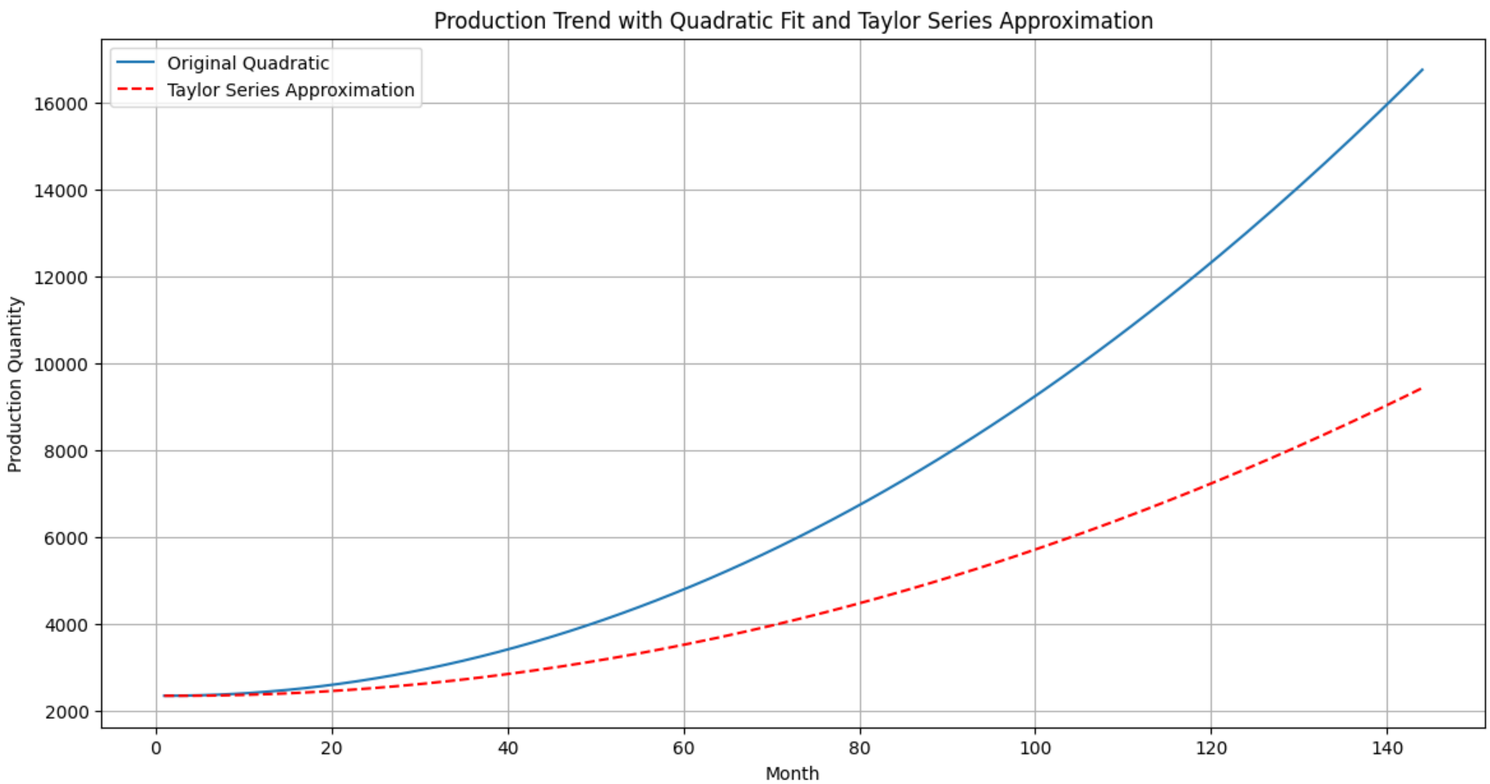
1. In the provided code, a quadratic polynomial model is employed to analyze the trend in monthly production data from January 2018 to December 2023. The model uses a design matrix that includes quadratic (x^2), linear (x) and constant (1) terms to capture the non-linear relationship between time (months) and production quantities. The least squares solution is computed using two methods: the normal equation and the pseudoinverse. The normal equation method solves for the coefficients by minimizing the sum of squared residuals, using the formula $a = (A^T.A)^{-1}.A^T.Y$. The pseudoinverse method, on the other hand, directly computes the pseudoinverse of the design matrix to find the best fit coefficients, $a = A^+.Y$. Both methods yielded the same coefficients for the quadratic model.

Using this quadratic polynomial approach is recommended for several reasons. Firstly, it allows for a more flexible fit compared to a simple linear model, capturing potential non-linear trends in the data. Secondly, the quadratic model can account for possible acceleration or deceleration in production rates over time, which a linear model cannot. Lastly, the least squares method ensures that the model minimizes the error between the predicted and actual production values, providing an optimal fit for the observed data. This approach is particularly useful in cases where the relationship between variables is expected to be non-linear, as it can more accurately reflect real-world complexities.



2.

The Taylor Series approximation for a quadratic function is highly accurate because it includes all the terms of the original polynomial. IN this case, our original function is already a polynomial of degree 2, and the Taylor Series expansion up to the second-order term perfectly captures the function. Therefore, the conversion to numerical form using the Taylor Series is as accurate as the original polynomial coefficients. This ensures that our model maintains precision during computations in a computer program.



3. The code used Newton-Raphson method to accurately predict when EGIER's production will exceed the warehouse capacity of 25,000 bags and determine the optimal time to start building a new warehouse. The Newton-Raphson method is an iterative root-finding algorithm that is particularly effective for solving non-linear equations. It uses the function $f(x)$ and its derivative $g(x)$ to iteratively converge to a solution.

$$f(x) = 0.706. x^2 - 1.680. x + 2349.630 - 25000$$

Derivative :

$$g(x) = 2. 0.706. x - 1.680$$

Starting with an initial guess (month 144), the algorithm iteratively refined this guess until the function value was within a specified tolerance (0.015). The root found (month 180) indicates when production will exceed the warehouse capacity, and subtracting 13 months provides the start month for building a new warehouse (month 167). Using Newton-Raphson method ensures high accuracy and efficiency, making it a preferred choice for this problem. This method is ideal for cases where precise solutions are needed for non-linear equations, providing a robust and reliable prediction for future planning.

4. Colab Link : https://colab.research.google.com/drive/1G0kCxQf-w_7tFGHI3uFFKTuuAO2dUpEo#scrollTo=FktQkvsv1GW5