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Standalone Desktop Application For Pumping Test Data Analysis

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Abstract -

There is an immediate necessity to look into how aquifers respond to different human activities in terms of both quantity and quality of groundwater. A stand-alone desktop application for evaluation and interpretation of pumping test data can be distributed as freeware for use by groundwater experts, researchers, students, teachers, and others. The pumping test is the most common and accepted technique for figuring out an aquifer's hydraulic properties.

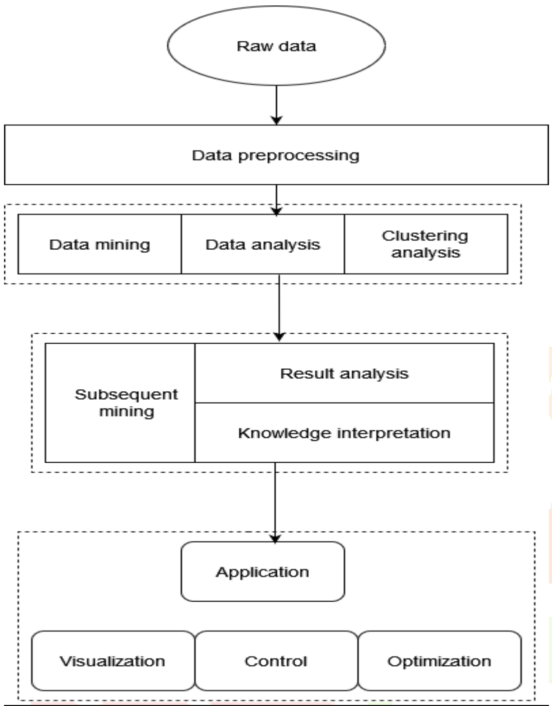
A pumping test help us determine a number of aquifers' properties, including transmissivity, storativity, and specific yield.Data from pumping tests are typically evaluated using computer programmes . Since there is no computer software offered in India for this use. The Central Ground Water Board is proposing to develop a stand-alone desktop application for the study and interpretation of pumping test data that can be used by groundwater specialists, pupils, researchers, educators, and other users. This software will be offered as freeware. The user has the option of directly entering data using interfaces or importing it from already-existing datasets.[3]

Expected result: a desktop programme that can analyse and interpret data from pumping tests on its own. The software application can include components for interpreting includes common techniques like Theiss, Theiss recovery, and Jacob technique.[3]

INTRODUCTION:

With the increase of human population its demands has increased and resources are limited and in one of those resources water is undisputedly holds the top spot. Since we get most of our water from groundwater resources the government and concerned authorities have increased their data collection and keep records of water levels and parameters related to aquifers. But for better and efficient use of the collected records we will use data analysis which comprises steps like data preprocessing which further includes data cleaning and data mining. Next steps include data analysis which includes result analysis ,knowledge interpretation and subsequent mining. Transmissivity (Ts) and storage coefficient(Se), two crucial aquifer parameters, are frequently assessed using groundwater pumping tests. Numerous mathematical models have been devised and released in academia to forecast the hydraulic characteristics of aquifers relying on the suitable system features and boundary conditions . The first model for forecasting rapid decline patterns in a restricted aquifer was a nonlinear equation put forth by Theiss. Later, a number of visualisation techniques for predicting Ts and Se parameters from data have been developed using the Theiss model. Theiss model has been expanded by researchers to describe many aquifer system types; for instance, Hantush created a semilogarithmic plot to analyse constrained leaky aquifers.For the analysis of pump test data from various types of aquifers, Kruseman and de Ridder offered comprehensive visual approaches. These graphical techniques may be arbitrary, and their outcomes may vary greatly.[1]

For instance, nanda and Thakur looked at the discharge rate variations that occurred during pump tests and showed how these affected Ts and Se values. One of the earliest studies to study pump test data using the least-squares method was McElwee, which showed that the automatic method produced good outcomes than the conventional visual fitting method.



Methods:

Pump Function of Theis:

The drawdown of the well can be derived by using - ΔD=do-d=(R/4πTs)P(v)

where R is the pump rate, d is the drawdown variable head, d0 is the initial drawdown head variable, d0 − d is the total drawdown, Ts is the aquifer transmissivity, and P(v) is the pump function. The coarse grained value of pump function can be derived by an never ending series :

P(v) = −0.5772 − ln(v) + $\sum_{n=1}$ (v^n/n.n!) − (v^n+1/n+1·n+1!)+(v^n+2/n+2·n+2!) −(v^n+3/n+3·n+3!) + · · ·

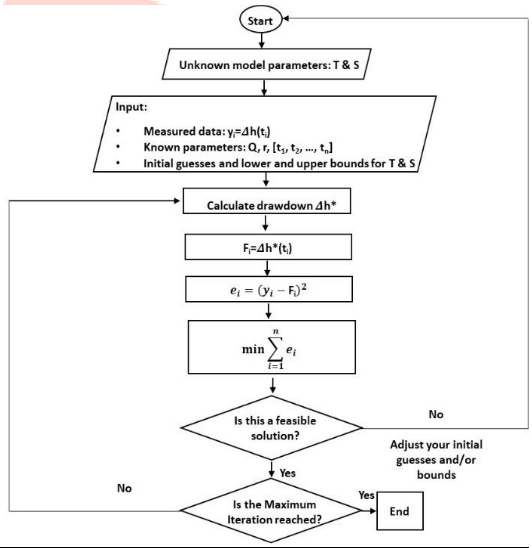
The following equation's definition of pump function for various values of v has been easily summed up.:

V=(r^2)Se/4(Ts)t

where Se is the aquifer storage coefficient, t represents the amount of time since pumping began, r is the radial distance from the observation well, and v is an arbitrary constant[1].

The Variable Estimation Method Used In Analysis:

The visual method, originally developed by Mr.Jacob and his team, is generally used theoretically to estimate drawdown data to the above method and approximate the Ts and Se values. To analyse the pumping test we employ a non linear solver from the python curve fitting library. The whole steps of fitting procedure can be summarised as below:



Hypothesize Values and Parameter Bounds for Ts and Se Values:

The Pumping Test Data Analysis requires the user to provide initial hypothesised values. In our project, the initial hypothesised value for Ts is set to 1 m2/d.

Approximately the minimum bound value of Ts is 0.01 m2/day, and the maximum bound is 1.0 × 105. The confined compressibility of an aquifer is typically 1.0 × 10−6, while the unconfined specific yield is typically 0.1.

Calculation of the Transmissivity and Storing Values Fallacy

The Theis graphical method cannot quantitatively estimate the errors in the approximate values of Ts and Se, which can lead to inaccuracy in the reported parameter values.
Value Curve fitting routines used in this study provide a covariance matrix comprising the framework values with the best match. This covariance matrix's square root corresponds to the square root of the fallacy underlying the parameter values. With this error estimate, the best-fit framework values may be published with the appropriate number of noteworthy figures by adhering to the conventional rounding method, which is outlined below.

Using a standardised scientific notation, the framework values and the corresponding fallacy values are expressed. unit, it is possible to determine how many significant figures should be used. Because fallacy estimates are estimates of what we do not know, we should round them up to one (maximum of two, in rare cases). Significant figure. One can then use the first non-zero numbers of the fallacy value to shorten the estimated parameter value's significant digit.

Test Problems Considered in This Study:

The dataset provided by Lohman represents the drawdown patterns in an abstract confined aquifer. We will use a Python tool to fit a simplified version of the aquifer model to the data and compare the results to the analytical solutions.
Our code is for solving practical problems with an extensive model of variables. The initial guess values and the variable bounds set within code were found to be effective in solving practical problems.
We tried a new approach for fitting ellipses to field data. Our approach is more robust to random alteration in the data and can handle huge size datasets.

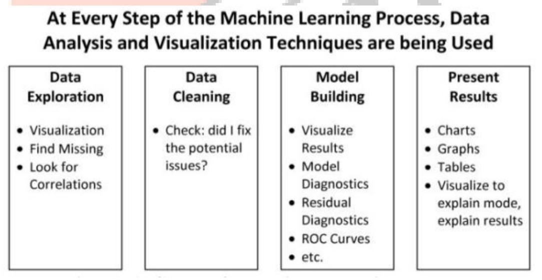
Data Analysis steps used:

1: Exploring the given data

Discovering what the data can tell us outside of formal modelling or hypothesis testing activities is the main goal of exploring the provided data.
The statistical aspects of the data sources should be highlighted, focusing on four key elements: the distribution's shape, the existence of outliers, and measures of central tendency.
We have outlined a description of these crucial components in the subsequent paragraphs.
Every stage of the machine learning process, as depicted in Figure , makes considerable use of data analysis and visualisation techniques.
The following methods are covered:

1. **Exploring The Dataset**

This is the first stage of data analysis. This gives us more information about the features and content of the dataset. It gives details on the data's magnitude. The data's missing value can be located. We can discover any potential relationships between the data. Tabular data is used to visualise data, and comprehension of the qualities is required.[4]



2. **Cleaning the dataset**

In this process we will iterate through the whole data set to identify duplicate data, wrong inputs and filter the information from the data, and then correcting the wrong data. The real process of cleaning data include removing mistakes and confirming information. We will be making python module which can be used to discover and correct inaccuracies. The problem may be fixed by validating the data.[4]

3. **Present output**

We can see enormous volumes of complicated data by utilising charts, graphs, and tables. Graphs and diagrams can aid in understanding the information. It is an easy way to communicate the concept. It can identify the areas that need work. It successfully makes the factor clear.[4]

Multivariate Visualisation:

1. Side-by-Side Boxplot
2. Scatter plots
3. Heat Maps and 3D Surface Plots
4. Eda In Python

Conclusion:

A software for analysing and visualising aquifer parameters and errors is used in this study. Program is an adaptable computer programme that makes use of free software to address estimate issues for hydrological parameters that need for nonlinear curve fitting procedures utilised for graphical estimation.

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