

“SPATIAL ANALYSIS FOR GAS FACILITIES”

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Abstract:

Gas utilities face many bottlenecks in managing field assets, inventory planning and tapping new customers because of the change in regulatory policies, fluctuating gas usage, pipeline leaks and so on. So a robust solution is required to handle such challenges which can be achieved by using spatial analytics to check the performance of gas assets and improve operations.

The ArcGIS Suite of products provide many spatial/non-spatial analytical capabilities and is also versatile enough to support the use of advanced techniques such as R and third party statistical software such as Tableau.

This paper explains the use of the R-ArcGIS Bridge by connecting ArcGIS to the R statistical computing software and creating statistical models using R with spatial data to support critical decision making. The paper also shows how the output can then be visualized using Tableau, a well-known interactive data visualization and business intelligence software, as Tableau can connect to R output to perform deep analysis in identifying several hidden patterns from source data like predicting potential gas leaks and calculating cost to company based on historical reports and customer data.

About the Author:



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7 years of experience in requirement analysis, designing, development and deploying GIS applications across several fields like Tele communications, Utilities, sales force and logistics. Worked as a senior developer on different GIS application stack and APIs.

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Introduction

The current Gas distribution landscape is changing, as with the ability to invest more into spatial analytics. Over a period of time several key factors like increase in gas usage, advanced technologies, pipeline incidents and new regulatory requirements are triggering gas pipeline companies to transform their traditional gas leak operations to cutting-edge predictive analysis for asset management and risk analysis. For such risk-based asset management, data is foundational which we attain through field observations and knowledge over the assets. So as to create a definitive risk model, historic gas leaks, gas leak inspections and customer data is captured over the years and this is squashed to derive significant conclusions. This is mainly helpful in correcting field data, focusing on pipeline safety and making necessary mitigation actions.

The current topic is one such foretelling approach to identify gas distribution pipes and customer meters that are at risk. This will have the ability to decide the service areas which are at potential risk by undertaking calculations on notable data. Based on such variety of data, key attributes for gas mains like – pipe age, pipe material, cathodic protection and so on are identified manually. Prioritizing these factors is challenging, but this is vital for identifying risk in that service area.

In addition to the conventional approach, this process leverages in defining weightage to each constraint based on its impact, there by calculating average weightage which is done using Tableau. The initiative has been implemented and tested on a client data with many of these parameters, and the results have been encouraging.

Design Considerations - How it works?

ArcGIS provides several spatial analysis tools for both raster and vector data through its Spatial Analyst extension. All these in-built tools aid in statistical computing and visualizing patterns. It also supports custom Python scripts and Geoprocessing Models through which we can compare results and derive hidden patterns. But not all kinds of statistical calculations can be performed and at times we need to depend on third-party softwares for the same and to visualize such outputs, we can rely on Tableau or Alteryx which has high capabilities in slicing data and proving business intelligence.

This solution is such attempt of leveraging ArcGIS content in Tableau which is very easy for such real time analytics. The overall architecture has Tableau and ArcGIS as an integral part of the solution. This integration is seamless to perform any calculations, analyzing output and generating customized reports. The same can be achieved from ArcMap as well, which is very tedious. Also we need to develop custom python script for analyzing output. In such cases, it is easy to incorporate Tableau which is very feasible.

Tableau connects and extracts the data stored in various places and this solution reads GIS data fields from the Geodatabase which are needed to forecast any unsafe service areas. To create such qualitative ranking of risks and have a subjective decision in managing the assets, it is mainly required to investigate Gas mains and meters. To start with it is necessary to identify important parameters based on asset conditions from the assessment data. These parameters change based on asset type and asset location.

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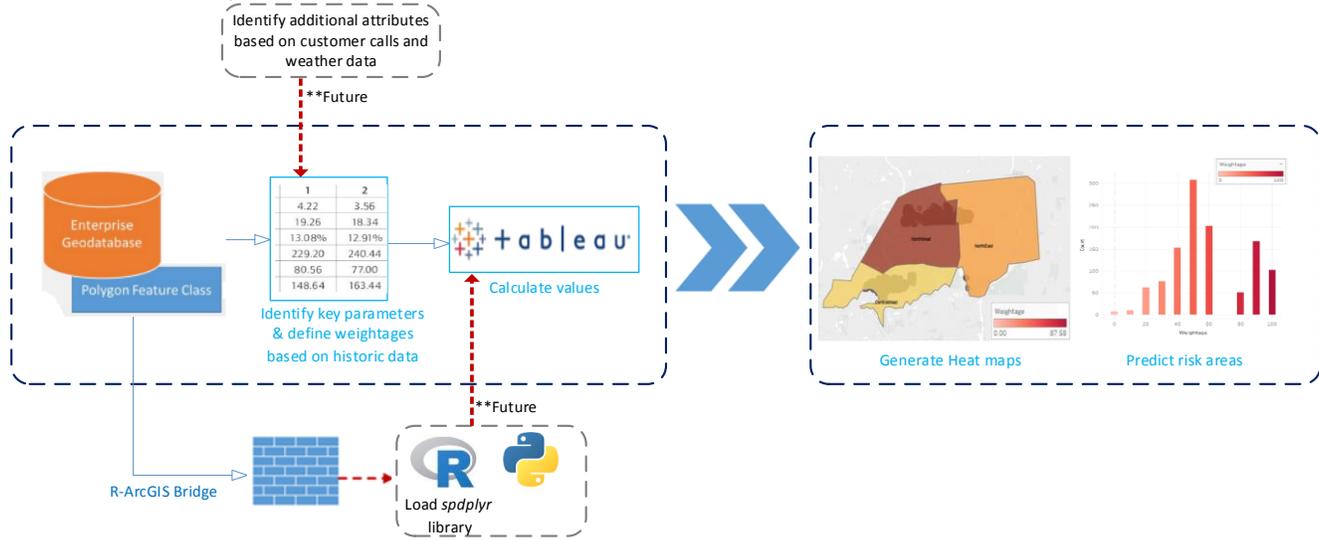


Fig: 1- High Level view of the solution

Once vital parameters are acquired, for each parameter, weightage is defined based on its impact. Later weightage calculations are achieved in Tableau so as to display the output in the attribute panel. This is prepared by creating custom fields in Tableau and then values are derived using weighted average method. Average weightage is computed for each parameter independently. Such weightage factor is determined for all constants and finally cumulative weightage for each gas asset is derived by summing up individual weightages.

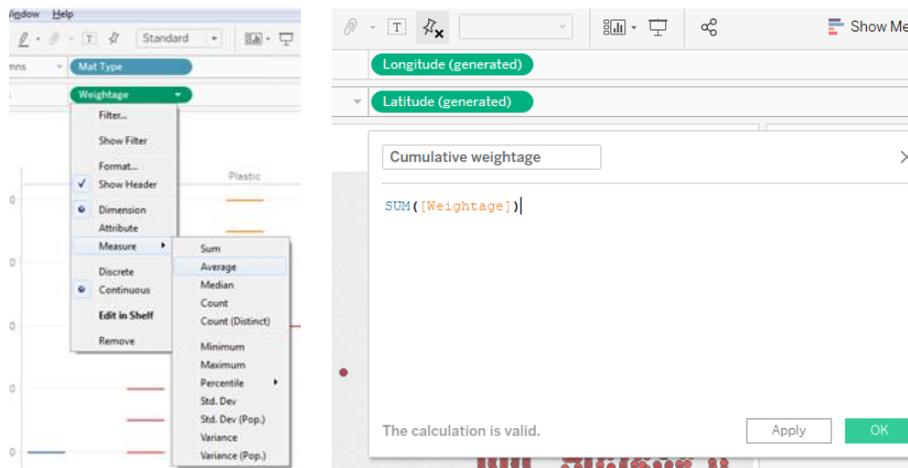


Fig: 2- Weightage calculation in Tableau

To scrutinize the data further, each parameter is mashed against its weightage and count to rationalize its impact in its survey area. Following histogram shows how pipe material type, pipe coating type and pipe condition influence the weightage in 'NorthWest' service areas.

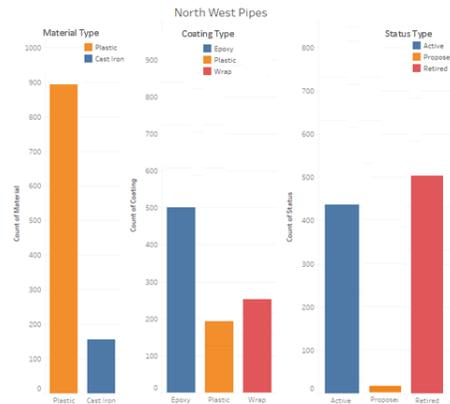


Fig: 3- Gas pipes in showing trends based on material type, coating type and status type

Using above factors, we are able to detect the service areas that are prone to hazards and the same can be visualized in the map window. Below Figure 4, depicts ‘NorthWest’ area as one such hotspot where there is high probability of getting into risk.

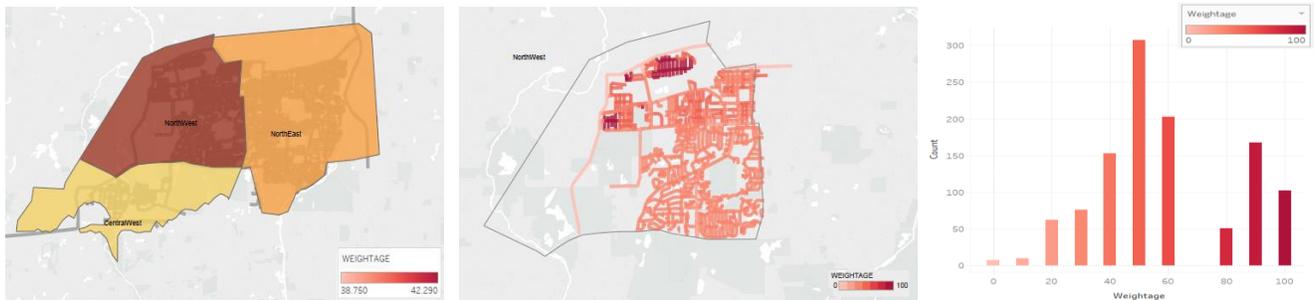


Fig: 4- Map view and graphical view of different survey areas based on weightage (from gas pipes)

Areas that are in safe zones are displayed in different symbology. From below map view, it is obvious that ‘CentralWest’ region is not at high and the same can be visualized as below:

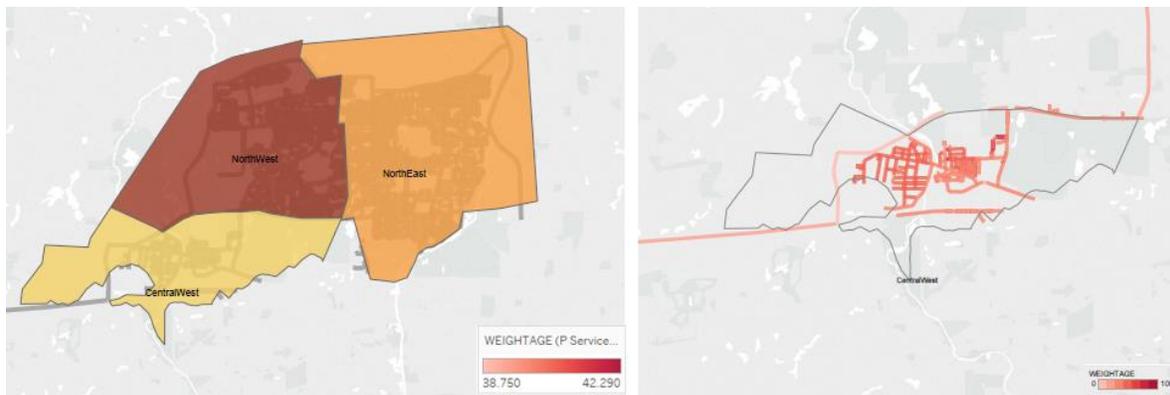


Fig: 5- Map view of ‘CentralWest’ region based on weightage

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The same output can be passed back to ArcGIS to generate similar report which will help in identifying other gas facilities linked to those gas mains. Similar forecast is derived by calculating weightage based on customer meters in some service areas. Like before, identifying predominant meter parameters is required for decision making and it is derived from customer calls. Some parameters include - meter last inspected date, meter conditions, meter status, meter last painted date and so on are included for calculations. Weightage is derived from the archival data and the Map view shows 'NorthWest' region has more chance in being a danger zone. These weightages were transmitted to derive histogram and the results are populated as per below screenshot.



Fig: 6- Map view and graphical view of different survey areas based on weightage (from meters)

This solution is designed based on gas facilities including gas facilities and customer meters. But apart from this list, climatic conditions (like humidity, temperature), soil conditions (like soil acidity, soil salt levels), third-party excavations and natural disasters etc. are some crucial factors that influence the predictive analysis.

The future capabilities (as indicated in Figure 1) are a lot more, and this will act as a foundation for all the future initiatives. One such leap is to perform all spatial calculations in R tool, since it provides *spdpplr* library with inbuilt capabilities for statistical computing and plotting output as required.

Key functionalities offered

The solution mentioned above can be embedded as a service offering in a variety of applications built on Esri platform. It can be added as a Geoprocessing tool to support some of the key business operations which would include the following:

1. Asset management can efficiently calculate material costs for all the facilities in high risky areas and find them quickly on the map.
2. Business can determine the service areas that are vulnerable to risks. Heat maps generated from this solution provide business intelligence for better planning.
3. Preventive maintenance operations can be performed based on the results by finding out specific areas geographically in map.
4. The solution will address safety concern to customers, by providing insights about the survey areas, gas facilities, emergency evacuation routes and gets notified accordingly.

Conclusion

With the advent of different visualization techniques and third-party statistical tools, the spatial analysis has taken a new leap. The solution connects to a diverse range of data sources to provide a predictive spatial model that will allow users to quickly and easily visualize the output spatially in the map view to take better decisions.

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The solution can be expanded further to connect through R libraries and interpret information obtained from historic gas leaks, real time data from field apps and web services.

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