Analysis and Research on Corrosion Law of Natural Environment of Materials

Mengru Zhang, Zhexu Xi
College of Chemistry and Chemical Engineering, Xiamen University, Xiamen, Fujian, 361005

Abstract. For the interaction of different types of materials, such as polymer materials, non-ferrous metals, ferrous metals and organic coatings, in the three different natural conditions of atmosphere, seawater and soil, this paper intends to analyze the data of corrosion datasets. It strives to introduce higher-dimensional, more accurate data, and proposes a more realistic and reference model mechanism by citing scientific optimization algorithms, which is more conducive to understanding the internal relationships between complex variables.

1. Introduction
The ever-changing innovation of high-tech industries is inseparable from the in-depth research and development based on materials, but at the same time, the corrosion of materials has become increasingly serious. As the data reserves become larger and larger, and the variables are intricate, the factors affecting each other and the changes over time make the data difficult to extract effectively. The internal process or mechanism for analyzing the corrosion of materials is becoming more difficult. Therefore, it is necessary to reasonably summarize and analyze the corrosion data of existing materials with large reserves and complex types, and then summarize the process, mechanism and internal laws of corrosion of metals in the natural environment.

2. Image text analysis

2.1. Model establishment
Firstly, the pixel information dot matrix of the image (the brightness of the image is qualitatively represented) is transformed into a quantifiable digital information by using different spectral conditions, and an m×n pixel dot matrix is generally introduced:

\[
I = I_{[m,n]} = \begin{bmatrix}
    i_{0,0} & i_{0,1} & \cdots & i_{0,n-1} \\
    i_{1,0} & i_{1,1} & \cdots & i_{1,n-1} \\
    \vdots & \vdots & \ddots & \vdots \\
    i_{m-1,0} & i_{m-1,1} & \cdots & i_{m-1,n-1}
\end{bmatrix}
\]

Generally, non-pure white or pure black images are color-decomposed, and further processed by means of clear color difference and local filtering processing, so that the grayscale image becomes a monochrome image. The image is then segmented into relatively independent tiny regions using...
appropriate segmentation techniques. According to the degree of corrosion of the material, it is roughly classified as follows: the appearance of corrosion of materials is mainly divided into rust spots, cracks, bubbling and peeling. The corrosion grade of the material is generally indicated by the size of the rust point or the density level of the bubble.

The ontology structure is based on the formalized description of the interrelationship between the material corrosion process and its natural factors based on the formal ontology language of OWL. This model is established to use the "seven-step method" proposed by Stanford University for ontology modeling: to determine the scope and scope of ontology; to examine the possibility of existing ontology reuse; to identify important terms in all ontology; to define concepts and concepts The hierarchy between the classes; defining the properties of the class; defining the facets of the properties; creating instances.

Then, a multi-attribute association algorithm is proposed to map the values of multiple environmental factors into a Boolean database, and then analyze the association rules between corrosion feature levels and natural environment factors. This algorithm is an update on the matrix-based SLIG algorithm, which not only saves the loss of time and space in the calculation, but also generates frequent itemsets through the operation of the relation matrix. The item set of multi-attribute association is expressed as: \( I_1 \times P \times P = \{(x, l, u) | x \in I_1, l \in P, u \in P, l \leq x \leq u \} \).

The multi-value attribute association algorithm divides each data into segments by static discretization processing and defines its categories in advance. According to this idea, the algorithm of multi-value attribute association is used to connect the data of corrosion grade and environmental factors in the established material corrosion heterogeneous database.

2.2. Model conclusions
After converting the real data set into a classified data set, it is continuously debugged until it is determined that the minimum support degree of 0.2 and the confidence level of 30% under the multi-value attribute association algorithm are found to be high in natural temperature (>20 °C). (65%~75%), the wind speed is large, the rainfall is large and weakly acidic. When the seawater salinity is large, the natural corrosion effect is the best and the appearance corrosion degree is the largest. The most closely related natural factors are humidity (precipitation), temperature and seawater salinity, and the effect is secondarily the air content of various sulfurized gases and nitrogen oxides.

3. Data text analysis

3.1. Model establishment
A considerable part of the corrosion data has the correlation of observations, and there are some differences in the distribution of data characteristics of different kinds of metals at different observation sites and tests. Through this qualitative feature cut-in, the corrosion data set of the material in the natural environment has a sharp hierarchical structure of longitudinal data. In order to optimize the algorithm for small sample data, the model based on hybrid model is used to estimate the fixed effect model by using the big tree algorithm, and the semi-parametric Bayesian algorithm of Dirichlet process is used to estimate the random effect part.

Based on two unrealistic assumptions in the hybrid model: the linear relationship between the fixed and random effects models and the response variables is determined; the data of the random effects satisfy the Gaussian distribution. Obviously, for the natural corrosion data in reality, the authenticity and adaptability of data reasoning cannot be neglected purely to simplify the calculation difficulty. This article takes the organic coating soil corrosion data as an example:

There are 15 species shown in the organic coating: HYi (i = 1~15), for each type in the data set, let \( \alpha_0 = 1, \lambda_0 = 0.001 \), the parameter \( m \) in the data set is assigned a value of 1, 10, 10000 and a reference value with strong reference. The specific method is to sample 5,000 times, the first 2500 times as a pre-test, the next 2500 times of normal data extraction, and the data record every five times to obtain 500 independent samples.
3.2. Model conclusions
For the aging of organic coating materials, it can be found through the test of the fixed model that the test area is the most influential factor, and from the textual information of the natural environment, it can be roughly inferred that the water, pH and salt in the soil are also the influential factors. By summarizing the data as follows:

| Material type | Test venue 1 | Test venue 2 | Test venue 3 | Test venue 4 | Test venue 5 | Test venue 6 | Test venue 7 | Test venue 8 |
|---------------|--------------|--------------|--------------|--------------|--------------|--------------|--------------|--------------|
| HY1           | HY2          | HY5          | HY6          | HY7          | HY8          | HY9          | HY10         | HY12         |
| Dagan g 24    | B2           | A5           | A4           | A4           | C30          | B2           | B2           | B2           |
| Dagan g 12    | B2           | A4           | A4           | A2           | C31          | B2           | B2           | B2           |
| Chengd u 24   | Dagan g 24   | CHengd u 24  | Daqin g 24   | Daqin g 24   | Korl a 24    | Korl a 12    | Korl a 12    | Korl a 12    |
| HY10          | HY12         | HY13         | HY14         | HY15         | HY10         | HY12         | HY13         | HY14         |
| A2            | A3           | A3           | A3           | A3           | HY13         | A3           | A3           | A3           |
| HY11          | HY12         | HY13         | HY14         | HY15         | HY11         | HY12         | HY13         | HY14         |
| HY12          | HY13         | HY14         | HY15         | HY12         | HY12         | HY13         | HY14         | HY15         |
| HY13          | HY14         | HY15         | HY12         | HY13         | HY12         | HY13         | HY14         | HY15         |
| HY14          | HY15         | HY12         | HY13         | HY14         | HY12         | HY13         | HY14         | HY15         |
| HY15          | HY12         | HY13         | HY14         | HY15         | HY12         | HY13         | HY14         | HY15         |

Using the semi-parametric Bayesian method of the random effects model $u_i$ for parameter estimation, the results are as follows:

| Material type | Random effect $u_i$ | M=1 | M=10 | M=10000 | m predicted value |
|---------------|---------------------|-----|------|---------|-------------------|
|               | intercept | Slope | intercept | Slope | intercept | Slope | intercept | Slope | intercept | Slope |
| HY1           | -4.653    | 0.957  | -18.938  | 1.574  | -20.059   | 1.986  | -6.785   | 1.102  |
| HY2           | -6.115    | 2.017  | -23.657  | 4.091  | -24.857   | 5.294  | -9.036   | 2.348  |
| HY5           | 4.253     | 1.183  | 17.962   | 2.847  | 20.946    | 4.067  | 6.751    | 1.326  |
| HY6           | -11.725   | 8.955  | -98.027  | 14.522 | -99.085   | 15.877 | -16.882  | 9.451  |
| HY7           | -0.976    | 0.836  | -11.757  | 1.496  | -14.256   | 2.841  | -3.454   | 0.974  |
| HY8           | -5.921    | 1.025  | -28.539  | 2.488  | -39.612   | 3.769  | -8.226   | 1.317  |
| HY9           | -5.878    | 2.322  | -26.005  | 4.613  | -30.593   | 6.258  | -6.993   | 2.501  |
| HY10          | -8.064    | 0.578  | -78.146  | 1.318  | -90.814   | 2.055  | -13.253  | 0.711  |
| HY12          | -6.993    | 1.036  | -25.914  | 2.743  | -31.257   | 4.054  | -8.057   | 1.462  |
| HY13          | 10.254    | 1.837  | 94.347   | 3.739  | 98.358    | 4.578  | 16.294   | 2.106  |
| HY14          | -10.275   | 2.055  | -18.659  | 4.263  | -21.062   | 4.953  | -12.058  | 2.583  |
| HY15          | -7.173    | 0.843  | -30.423  | 2.063  | -33.674   | 2.762  | -10.216  | 1.193  |

It can be seen from the data distribution that the parameters such as the mean square error of the estimated parameter values under different aggregation parameter levels are completely different, indicating that the setting of the random effect term is reasonable and feasible. According to the definition of the Dirichlet process, the larger the m value, the closer the random effect distribution curve is to the basic distribution. Therefore, the difference in m values also has a large influence on the difference in distribution shape.
Through continuous experimentation, fitting the final results also found that the exposure time and the difference of the test area have the greatest weight effect on the corrosion of metal materials under natural conditions, and the coefficients can reach 38.129 and 35.824, respectively.

4. Conclusion
In addition to ensuring the smooth progress of the simulation results, this paper highlights the innovation of algorithm design and data prediction. Through the continuous optimization and debugging of algorithms and the application of new databases, the aim is to apply more scientific and systematic mathematical principles to database science and data. Mining analysis, but found that some of the variable mapping relationship and the database need to be manually coded, it is more difficult. Because the natural condition test period is long and the cost is high, it is of great practical significance to improve the simulation technology of the laboratory and the correlation between the long and short period natural corrosion test.

References
[1] Cao Chunan. Natural environmental corrosion of Chinese materials [m]. Beijing Chemical Press, 2005.
[2] Li Xiaogang. Progress and Prospects of Research on Natural Environment Corrosion of Materials in China [j]. China Science Foundation, 2012, 5: 257-263.
[3] Wang Guangqi. Discussion on the status quo and suggestions of material science data sharing from the field of material natural environment corrosion [j]. Basic Science of China, 2003(1): 82-84.
[4] Chai Liuxiang, He Feng. Research Based on Jena and Its Ontology Reasoning [J]. Computer Technology and Development, 2011, 11(21): 117-120.