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Research Workflow Automation via N8N: A Powerful Tool for Routine Geophysical Data Processing

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Introduction

N8N is an open-source workflow automation platform based on the "low-code" concept, enabling the creation of complex automation systems through an intuitive visual interface. Built on an architecture of interconnectable nodes, n8n operates on the paradigm of flow-based programming, where each node represents a specific function that processes data and passes it to subsequent nodes. This revolutionary approach to process automation is particularly relevant for geophysical applications, where we frequently deal with repetitive workflows involving data acquisition, processing, and analysis. The platform stands out for its flexibility, allowing integration with various programming languages (such as Python and R), databases, REST APIs, and cloud services, making it an ideal solution for optimizing geophysical processing pipelines. This work explores n8n's capabilities as a versatile solution to streamline routine geophysical processes and serve as an accessible interface for executing complex computational routines, democratizing access to advanced processing tools.

Method

The theoretical foundation of n8n rests on three main pillars: modularity, interoperability, and scalability. In practice, workflows are constructed by combining different types of specialized nodes. Input nodes (such as HTTP Request or Spreadsheet) capture raw data, which is then processed by transformation nodes and finally delivered by output nodes. For geophysical applications, we developed custom nodes that integrate specialized tools like PyGMT for gravimetric processing and SimPEG for electrical modeling. This requires terminal connectivity to execute codes that can be read from either local computers or the cloud. The platform implements a robust error-handling and operation-retry system, ensuring the reliability of automated processes. A crucial theoretical aspect is N8N's ability to orchestrate asynchronous processes, enabling parallel execution of computationally intensive tasks—particularly advantageous for processing large volumes of geophysical data.

Results and Conclusions

The implementation of n8n in geophysical workflows demonstrated significant improvements in efficiency and reproducibility. In practice, we reduced gravimetric data processing time by up to 70% through automation of quality control, instrumental correction, and map generation steps. For electrical data, the automated system enabled simultaneous execution of multiple inversion scenarios with different initial parameters. The platform also proved exceptional as an abstraction layer, allowing researchers with limited programming experience to perform complex analyses through simplified interfaces. We conclude that N8N represents a significant advancement in democratizing computational tools for geophysics, offering an ideal balance between technical flexibility and accessibility. Its visual flow-based model not only accelerates the development of customized solutions but also facilitates the documentation and replication of research workflows—critical aspects for ensuring scientific reproducibility in applied geophysics. Nevertheless, it is important to highlight that geophysicists should not disregard fundamental theoretical knowledge and programming skills, as these remain essential for advancing the science.