



TITLE:

Solid-earth structure and dynamics approached by the intelligent measurement analysis

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CITATION:

Kuwatani, Tatsu. Solid-earth structure and dynamics approached by the intelligent measurement analysis. 海域における地震・火山災害の軽減に資する地球電磁気学的アプローチの探求 2023: 共同研究(一般研究集会)2022K-04.

ISSUE DATE:

2023-05

URL:

<http://hdl.handle.net/2433/285650>

RIGHT:

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In recent years, many attempts have been made to extract the essential information from various measurement and observation datasets using mathematical and information scientific methods. Such attempts are sometimes collectively called the data-driven analysis or the intelligent measurement analysis. The key points of the intelligent measurement analysis are as follows (Fig. 1). Both of the generating process of data obtained by measurement, or called the measurement process, and the prior knowledge of the target to be measured are mathematically modeled, and they are incorporated to the inverse analysis of the physical quantity of the target to be measured. Bayesian inference and sparse modeling are basic concepts and mathematical foundations for appropriately designing mathematical problems for such inverse analyses depending on actual problem settings and datasets.

In the presentation, as an example of the intelligent measurement analysis, I will discuss the research that estimates the three-dimensional magnetization structure inside the Nishinoshima volcano from the aeromagnetic data obtained by drone observations (Tada et al. 2021). In particular, we focus on the problem of hyperparameter estimation, that is, how to objectively determine the weights of the measurement process and prior knowledge terms in the evaluation function. In addition, we briefly introduce a new hyperparameter-estimation method (Kuwatani et al. 2022) with an example of denoising the X-ray radiographs.

Kuwatani T, H Hino, K Nagata, T Kawashima, M Toriumi, M Okada, “Hyperparameter estimation using resolution matrix for Bayesian sensing”, *Inverse Problems*, 38, 124004 (2022) <https://doi.org/10.1088/1361-6420/ac93ad>

Tada N, H Ichihara, M Nakano, M Utsugi, T Koyama, T Kuwatani, K Baba, F Maeno, A Takagi, M Takeo, “Magnetization structure of Nishinoshima volcano, Ogasawara island arc, obtained from magnetic surveys using an unmanned aerial vehicle”, *Journal of Volcanology and Geothermal Research*, 419, 107349 (2021) <https://doi.org/10.1016/j.jvolgeores.2021.107349>

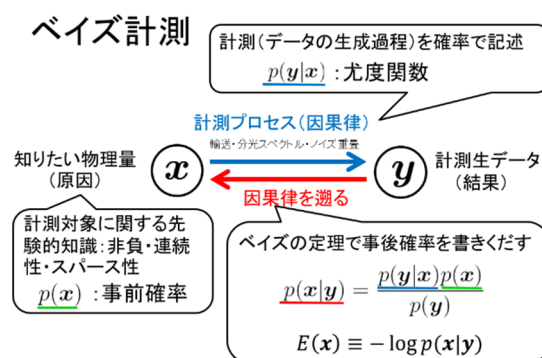


Fig. 1: Schematic slide for the Bayesian sensing as a key concept of the intelligent measurement analysis