Data science in interdisciplinary research on disaster mitigation

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This talk will introduce how disaster related data can be used for various topics on disaster research and disaster mitigation in practical.
The 2011 Great East Japan Earthquake will be used as an example of big data such as building damage data, satellite images, traffic congestion that were used for hazard/risk assessment and reconstruction plan.

Keywords: Tsunami, hazard, risk, disaster mitigation

Data science in applied chemistry: The user's point of view.

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Data science and machine learning have become valuable tools that accelerate scientific research across various fields. In this seminar, I will share my experience collaborating with data scientists to apply machine learning in my research and discuss potential perspectives in chemistry. As I am not a specialist in data science, I will focus on what we need as the "end user" rather than the applied algorithms.

1. Chemical biology: The design of green fluorescence protein for cyborg protein construction

Protein is defined as the polymer of amino acids with peptide bonds. Our idea is to replace part(s) of a polymer chain with artificial polymer, resulting in "cyborg proteins." To construct cyborg proteins, the starting mutants with preferred properties must be chosen, and sometimes it is difficult. In this work, we realized that it was difficult to obtain gree fluorescence protein that still show fluorescence after mutations at certain amino acids. Here, we used machine learning to help predict such difficult-to-mutants

2. Spectroscopy: Overcome the limitations of signal-to-noise ratio

Signal-to-Noise Ratio (SNR) is the most fundamental property of any measurement, especially for spectroscopic techniques, that must be considered. SNR determines whether the obtained data has a scientific meaning or not, and it is also an indicator of the sensitivity of instruments or measuring conditions. In this section, I will briefly introduce some of the spectroscopic techniques that use machine learning for improvement and instrumental development.

3. Microscopy: Extract useful data from numerous images

The most time-consuming step in microscopy is to count and/or measure samples in the images to get the statistical representations of each sample. Many image-processing algorithms have been developed. However, most of them are sample-specific and do not allow the distinction of different morphologies. Here, I would like to share my recent challenge from the end-user's point of view.

Gentle Introduction to Vision-Language Alignment

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Learning from multiple modalities (e.g., image, text, audio, etc) is gaining momentum in both research and industry. Among these, vision-language learning is particularly active. Notably, GPT-4 has demonstrated remarkable capabilities in understanding both text and images. The key to this success lies in aligning vision and language modalities into a unified embedding space, achieved through two main approaches: discriminative alignment and generative alignment.

In this talk, I will give a gentle introduction to vision-language alignment, discussing its significance and the methodologies involved. Discriminative alignment, exemplified by CLIP, uses contrastive learning to align images and text effectively. On the other hand, generative alignment has gained prominence with the rise of large language models. I will also share how we have applied these techniques in our research work.

Keywords: Vision-Language Alignment, Vision-Language Learning.

Elucidation of local climate adaptation using natural variation

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Many plant species have succeeded in colonizing a wide range of diverse climates through local adaptation, but the underlying molecular genetics remain obscure. We previously found that winter survival was a direct target of selection during colonization of Japan by the perennial legume Lotus japonicus and identified associated candidate genes. Here, we show that two of these, the *FERONIA-receptor like kinase (LjFER)* and a novel S-receptor-like kinase *(LjLecRK)* are required for non-acclimated freezing tolerance and show haplotype-dependent cold-responsive expression. Moreover, by recruiting haplotype of these receptor kinases bring the up regulation of the set of genes that provide protection against harsh winter including cell wall and cell membrane metabolism. Our work demonstrates that recruiting a conserved growth regulator, *FER*, and a novel receptor-like kinase, *LecRK*, into the set of cold-responsive genes has contributed to freezing tolerance and local climate adaptation in *L. japonicus*, offering new functional genetic insight into perennial herb evolution.