From artisanship to amateur: the challenge to identify large fossils using deep learning

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Deep Learning is a machine learning technique that allows computers to process raw data effectively. Specifically, Deep Convolutional Neural Networks (CNNs) lead to the recent success of Deep Learning in the computer vision field and achieve near-human or super-human performance on various image recognition tasks, such as image classification. CNNs learn from data to how to process data and have surpassed previous hand-crafted methods, which are carefully designed by experts. Large fossils are generally identified based on 3D morphological characters, and these characters are difficult to find except for specialists of the specific taxon of large fossils. Therefore, the identifications of fossils are treated as “artisanship.”

An extinct bivalves clade of Inoceramidae is abundant from the upper Cretaceous in Japan. More than 450 occurrences of inoceramids (paleoDB Feb.2020) were reported from Japan. These inoceramids are classified into more than 4 genera, 6 subgenera, and >50 species. Almost all species have a very short stratigraphic range, and therefore inoceramids are favorable for index fossils.

However, morphological differences between some species are small and sometimes indistinguishable for non-experts. Diagnostic features are not limited to a specific region or structure in a shell and are not defined quantitatively. Thus, learning the identification skill of inoceramids requires many years of experience and mentors who can correctly discriminate one’s identifications.

Unfortunately, the specialists of inoceramid taxonomy are at risk of “extinction” in Japan. Only one or two active researcher(s) struggle for classification or systematics of inoceramids. In contrast, for the majority of paleontologists, fossil identification was a “tool” for other research. These researchers cannot spare their time in learning the identification of inoceramids.

To overcome this situation, we will propose to use CNNs for the automatic classification of inoceramids. For this purpose, we collected 2D images of several species of Inoceramidae from 3D surfaces models for reducing their fossil color effects. After the collection, we will train CNNs to identify the species of images correctly. Because the number of available images of fossils is limited compared to other domains, we will also study methods to virtually increase the amount of data for better classification accuracy.

