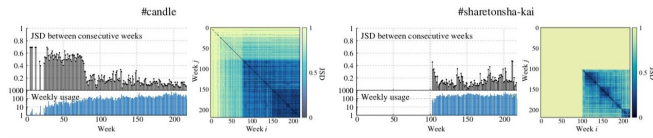


Exploring open-ended evolution in web services

11 April 2019, by Ingrid Fadelli



Examples of converging (left; #candle) and non-converging (right; #sharetonsha-kai) cases; “#sharetonsha-kai” means “fashionable/cool”+“club”. In both cases, the upper left panel shows the transition of the JSD between two consecutive weeks, which exhibits a decreasing behavior and some spikes in the left and right case, respectively. Credit: Ikegami et al.

Just like living ecosystems, web services form a complex artificial system consisting of tags and the user-generated media associated with them, such as photographs, movies and web pages. When drawing an analogy between biological and artificial ecosystems, tags could be regarded as species and human users as hidden environmental resources.

Based on this idea, researchers at the University of Tokyo and the University of Tsukuba have recently carried out a study aimed at analyzing the evolution of [web services](#), particularly [social media](#) tagging systems, focusing on the self-organization of new tags. Their paper, [pre-published on arXiv](#), argues that some tags on social media platforms offer an example of open-ended evolution (OEE), which entails the creation of truly open-ended computational evolutionary processes.

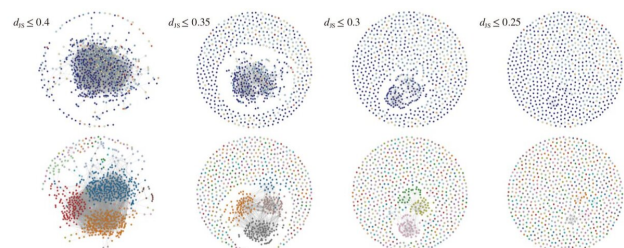
"A key goal of my work is to understand what life is, how artificial systems become biological, and how to develop the concepts of [artificial life](#) as new technology," Takashi Ikegami, one of the researchers who carried out the study, told TechXplore. "Artificial life (ALIFE) is a research field aimed at understanding life not as something

based on DNA and cells, but as emergent phenomena. ALIFE shows how DNA and cells can be replaced by something else, e.g. computer programs, chemical networks and robots. Based on this idea, in this paper, we wanted to show that the web is becoming a living system."

According to Ikegami and his colleagues, analyzing the dynamics of web systems could ultimately help to re-shape and update Darwin's theory of evolution. One of the main topics of interest for ALIFE researchers is open-ended evolution (OEE), particularly what causes it, and how it can be applied to computational artificial systems.

In their study, the researchers examined tag data with its relevant user community in order to understand how the OEE of web services can be measured. According to Ikegami, the evolution of new tags is a key index of web evolution. Other indicators include a novel combination of tag sets, the development of meanings/semantics of tags, and the improvement of user community structures.

"The combination of existing tags can be developed even without having new tags," Ikegami said. "This is one idea that allowed us to measure the production rate of novel pairs in the data. In order to quantify the meaning of a tag, we used a set of tags simultaneously with the tag. We found that the meanings, a set of co-used tags, changes over time in the dataset."



Tag novelty rate (the upper column) and the community structure (the lower column) of the user similarity network on RoomClip. Each node is a user, and is connected if dJS is less than the threshold values 0.4, 0.35, 0.3, and 0.25 from left to right. The top four figures show the number of tags created by individuals in color; shifting from blue to yellow to red means that they have created more words. The bottom four figures show the community structures detected in each network. In these figures, the isolated users (in the peripheral) create novel tags at a high rate. Credit: Ikegami et al.

In their study, Ikegami and his colleagues measured the structure of user communities by introducing the concept of 'distance' between users. They analyzed communities of users as they matured over time, focusing on three web services: Delicious, Flickr and RoomClip.

"A key finding of our study is that we could characterize the evolution of the meaning of tags and found examples of OEE in the web dataset we used," Ikegami said. "Another interesting result is that we were able to characterize the pair novelty rate of tags in web services. Finally, we could also characterize the evolution of a community of users at the same time."

The results of the analyses carried out by Ikegami and his colleagues suggest that some popular tags used in online communities can exhibit OEE as they semantically converge with other sets of tags. The OEE dynamic observed by the researchers has two distinct layers: a web service's social tagging system and the human community posting tags online. Although further analyses are required to confirm their findings, they believe that what they observed corresponds to Ackley's definition of OEE's indefinite scalability, which highlights that OEE should "support open-ended computational growth without requiring substantial engineering."

Comparing the findings gathered by the team to the current understanding of biological evolution, a set of tags could be considered as a genotype and associated photographs or media as a phenotype. This phenotype would be characterized by a combination of tags, while the shift of a tag into a new related tag or set of tags reported in their study

could be interpreted as the [emergence](#) of a new "species."

Overall, Ikegami and his colleagues view instances in which popular tags continuously evolve, leading to the continuous creation of new tags, as evidence of OEE. Their study offers interesting insight into how the evolution of meaning in society could be measured. Their findings also suggest that this evolution might be associated with changes in a community's structure.

"We are now planning to study how community structures change over time and how this is related to the [evolution](#) of meanings and vice versa," Ikegami said. "At the same time, we wish to develop a theoretical model to capture the new qualities we found in this study."

More information: Open-ended evolution and a mechanism of novelties in web services. arXiv:1903.12178 [cs.SI]. arxiv.org/abs/1903.12178

Infinitely scalable computing= artificial life engineering. DOI: [10.7551/978-0-262-32621-6-ch098](https://doi.org/10.7551/978-0-262-32621-6-ch098). <https://pdfs.semanticscholar.org/4a54/efd21ab84093fa6d631ffc6663241d8441ae.pdf>

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APA citation: Exploring open-ended evolution in web services (2019, April 11) retrieved 22 April 2019 from <https://techxplore.com/news/2019-04-exploring-open-ended-evolution-web.html>

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