Interactive cloud experimentation for biology: Systems architecture and educational use case

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We present a cloud experimentation architecture (paralleling cloud computation) [1], [2], [3], which is optimized for a class of domain-specific equipment (biotic processing units - BPU) to share and execute many experiments in parallel remotely and interactively at all time. We implemented an instance of this architecture with a Lego Mindstorms liquid handling and imaging robot to carry out chemotactic experiments with the slime mold *Physarum polycephalum*. A user study in the blended teaching and research setting of a graduate-level biophysics class demonstrated that this platform lowers the access barrier for non-biologists, enables discovery, and facilitates learning analytics. We discuss how this architecture is flexible for integration with various biological specimens and equipments to facilitate many other "interactive biotechnology" applications, such as scalable interactive online education, collaborations, conventional research, mini-clouds in school settings, and citizen science.

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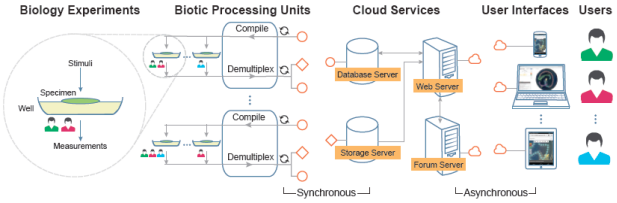

Figure 1: A turn-based cloud lab architecture enables large user numbers to execute biology experiments on shared equipment.

Figure 2: The spatiotemporal chemotactic growth response of the slime mold *P. polycephalum* (yellow) to an oatmeal solution trail (red) offers a scientifically interesting experimental paradigm with high-dimensional input/ output spaces.

REFERENCES

[1] Z. Hossain, X. Jin, E. Baumbacher, A. M. Chung, S. K. J. D. Shapiro, C. Y. Truong, S. Choi, N. D. Orloff, P. Blikstein, and I. H. Riedel-Kruse, "Interactive Cloud Experimentation for Biology: An Online Education Case Study," *Chi*, 2015.

[2] L. Gomes and S. Bogosyan, "Current Trends in Remote Laboratories," *IEEE Trans. Ind. Electron.*, vol. 56, no. 12, pp. 4744–4756, Dec. 2009.

[3] C. Gravier, J. Fayolle, B. Bayard, M. Ates, and J. Lardon, "State of the art about remote laboratories paradigms-foundations of ongoing mutations," *International Journal of Online Engineering*, vol. 4, no. 1, 2008.

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