Life Sciences Computing

Thomas Jepsen, *IT consultant*
Jinan Fiaidhi, *Lakehead University, Canada*
Reza Djavanshir, *Johns Hopkins University*

Biological research in the life sciences is changing rapidly, generating vast amounts of data on exceedingly complex regulatory systems. Increasingly, more computational sciences and engineering methodologies and techniques are involved in life sciences research.

In the past, the term "life sciences" was used to refer to the study of life forms and their organization in fields such as biology, medicine, and ecology. These were considered to be separate fields from traditional engineering, which relied on scientific principles to design and manufacture products. Today, this distinction has been blurred, with biological sciences becoming increasingly computerized and engineering principles being applied to the study of life forms and the environment.

Computational Life Sciences

The new field of computational life sciences (CLS) is becoming one of the most important and exciting areas in all of science and technology. CLS is positioned at the intersection of modern biology, bioinformatics, genomics, big data analytics, quantitative mathematical modeling, knowledge discovery and synthesis, text mining, computational bio-imaging, medical sciences, molecular dynamics, and high performance computing. The complexity of biological systems requires a CLS approach to understand the functioning of the regulatory networks, and to go from isolated qualitative descriptions to a larger quantitative understanding.

CLS is having a wide impact on a variety of technologies, including the development of biomarkers, therapy targets, and drug discovery (see the "Related Resources in Computational Life Sciences" sidebar). Thus, a major challenge for CLS research in the next decades is to extract useful information from vast amounts of data and to develop computational models to investigate the complex dynamics of living organisms.

In this Issue

Our feature topic on life sciences in this special issue addresses a number of areas where theoretical science meets engineering practice. The first article, "Feature Selection in Life Science Classification: Metaheuristic Swarm Search," by Simon Fong, Suash Deb, Xin-She Yang, and Jinyan Li, proposes Swarm Search Feature Selection (SS-FS) as a feasible computing tool for use in medical informatics feature selection as a means of achieving

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Related Resources in Computational Life Sciences

Advances in CLS are contributing to the following emerging research areas:

- personalized medicine and drug discovery;
- cell-level diagnosis and therapy;
- simulations of biomolecules under cellular environments;
- hierarchical integrated simulation for predictive medicine;
- large-scale analysis of life data;
- computational biomodeling, genomics, neuroscience, pharmacology, and evolutionary biology; and
- cancer computational biology.

There are several large conferences that are concerned with computational life sciences, including

- the International Symposium on Computational Models in Life Sciences (http://cmls-conf.org),
- the European Conference on Computational Biology (www.eccb14.org),
- the International Conference on Practical Applications of Computational Biology & Bioinformatics (www.pacbb.net), and
- the ACM Conference on Bioinformatics, Computational Biology and Health Informatics (www.cse.buffalo.edu/ACM-BCB2014).

There are also numerous journals dedicated to CLS. Some notable examples include

- *Interdisciplinary Sciences: Computational Life Sciences Journal* (http://link.springer.com/journal/12539),
- *Journal of Computational Science* (www.journals.elsevier.com/journal-of-computational-science),
- *Journal of Computational Biology* (www.liebertpub.com/CMB) and
- *PLoS Computational Biology* (www.ploscompbiol.org).

There's also the IEEE/ACM Transaction on Computational Biology and Bioinformatics (www.computer.org/portal/web/tcbb), and major science and engineering societies are creating specialized CLS technical groups (such as the IEEE Technical Committee on Computational Life Sciences, www.ittc.ku.edu/chenlab/tccls).

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high accuracy in classification via testing with two empirical biomedical datasets.

The next article, "Governance of Cloud Computing Services for the Life Sciences," by Srdan Dzombeta, Vladimir Stantchev, Ricardo Colomo-Palacios, Knud Brandis, and Knut Haufe, analyzes legal regulatory issues surrounding cloud computing in health care and proposes an implementation roadmap.

The final theme article, "Alice in 'Bio-land': Engineering Challenges in the World of Life Sciences," by Alfredo Benso, Stefano Di Carlo, Gianfranco Politano, Alessandro Savino, and Enrico Bucci, discusses how we see the role of systems and computational biology as a "middle ground" between differing methodological approaches.

This issue also includes an interview with Eric Topol, a practicing cardiologist with Scripps Clinic in La Jolla, California, and a pioneer in the field of cardiovascular medicine. Topol's research interests include the use of preventive medicine, wireless digital technologies, and genomics to reshape the future of medicine. A practicing physician as well as a researcher, Topol believes that patients should be fully empowered. He ensures this by sharing information completely and building a partnership with his patients.

CLS aims to integrate two diverse pillars of modern scientific discovery—the quantitative sciences and life sciences. As it continues to foster interdisciplinary research and development, it will be interesting to see how its flexible computational models and advanced simulation tools will help advance our understanding of the complex biophysical processes, structures, and interactions of the human body and of human diseases to improve our quality of life and extend our years of healthy living.

Thomas Jepsen *is an independent IT consultant. His interests include health information technology, interoperability, and the history of technology. He is the author of*

Distributed Storage Networks: Architecture, Protocols and Management *(Wiley, 2003) and a contributor to* Systems Engineering Approach to Medical Automation *(Artech House, 2008) and* Encyclopedia of Software Engineering *(Taylor & Francis, 2010). He received the IEEE-USA Citation of Honor in 2009. Contact him attjepsen@ieee.org.*

Jinan Fiaidhi *is a full professor and the Graduate Coordinator in the Department of Computer Science at Lakehead University, Canada. She is also an adjunct research professor with the University of Western Ontario. Her research is focused on mobile and ubiquitous learning utilizing emerging technologies (such as cloud computing, calm computing, and mobile learning). Fiaidhi is a Professional Software Engineer of Ontario (PEng), Senior Member of IEEE, member of the British Computer Society (MBCS), and a member of the Canadian Information Society (CIPS) holding the designate of ISP. Contact her at jfiaidhi@lakeheadu.ca.*

Reza Djavanshir *is an associate professor of information systems at Johns Hopkins University. His research interests include system-of-systems and metasystems design, technology strategy, and global sourcing. Djavanshir has a PhD in systems engineering from George Washington University. Contact him at rj@jhu.edu.*