DNA Nanotechnology and Molecular Computing

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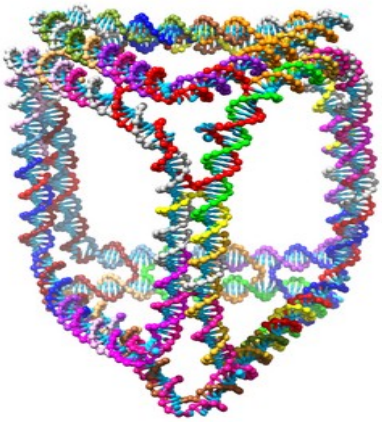

DNA nanotechnology provides a novel substrate to interface computational algorithms with the world of the living – with a widening range of applications in biotechnology, pharmacology, and agriculture. Since DNA has been recognised as a universal substrate for computing [1-2] more than two decades ago, numerous molecular circuits have been devised for sensing [3], processing [4] and storing [5] molecular information. Recent research has seen a surge in the development of molecular neural networks and related models of computation [6].

Selected Project Directions

- Design and analysis of molecular algorithms and DNA computing circuits
- Online and offline learning in molecular neural networks
- Molecular and coarse-grained physical modeling of nucleic acid interactions
- Specification-driven *de-novo* design of DNA strand displacement circuits
- Optimization of large scale DNA strand displacement networks

Successful candidates will have an MSc in Computer Science, Mathematics, Physics, Computational Chemistry or a comparable background.

Research Environment

Newcastle University's School of Computing is among the first Computer Science departments in the country. Its Interdisciplinary Computing and Complex Biosystems Research Group (ICOS) performs cutting-edge research at the interface of Computer Science and the Life Sciences – with world-leading expertise in bioinformatics, medical informatics, machine learning, synthetic biology, and DNA nanotechnology. The group entertains its own molecular biology laboratory that the candidate will have access to. The group entertains close ties with regional industrial startups specialised on developing molecular computing solutions for biotechnology and medical diagnostics – offering the candidate to learn about entrepreneurship and to demonstrate real-world research impact where desired.

References

[1] Soloveichik et al. DNA as a universal substrate for chemical kinetics (2010) *Proc. Nat. Acad. Sci. USA* 107(12):5394
[2] Cardelli Two-domain DNA strand displacement (2013) *Math. Struct. Comp. Sci.* 23(2):247
[3] Jung and Ellington Diagnostic applications of nucleic acid circuits (2014) *Acc. Chem. Res.* 47(6):1825
[4] Seelig et al. Enzyme-free nucleic acid logic circuits (2006) *Science* 314(5805):1585
[5] Lopiccolo et al. A last-in-first-out stack data structure implemented in DNA (2021) *Nat. Commun.* 12(1):4861
[6] Qian et al. Neural network computation with DNA strand displacement cascades (2011) Nature 475(7356):368