Activity Report
Long-term Overseas Dispatch
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Study Abroad in Helsinki

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Thanks to a Long-term Overseas Dispatch program, an elective research training in MERIT, I studied Computer Science at Aalto University in Helsinki for two months. Helsinki is the capital of Finland, and located in southern Finland on the shore of Baltic Sea. Aalto University is a new university created from the merger of three leading Finnish universities: the Helsinki University of Technology, the Helsinki School of Economics, and the University of Art and Design Helsinki. There was plenty of opportunities to meet people with a variety of backgrounds.

My research theme at Aalto University was that a design and optimization of DNA self-assembly. I studied under Prof. Pekka Orponen whose research group is one of leading groups studying algorithmic DNA self-assembly. DNA self-assembly is a process in which pieces of DNA molecules autonomously form an organized structure such as a box, a sphere, a spider, etc. Technology using DNA self-assembly has a huge potential to be applied in molecular scale electronics and nanomedicine. One of challenges in the technology is that yields of DNA structures critically depend on their shapes. To construct complex DNA structures with high

Figure 1: Finland is a country of forests and lakes.

Figure 2: The auditorium of Aalto University, which was designed by architect Alvar Aalto.

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yields, a methodology to design and optimize DNA self-assembly is necessary.

After I arrived in Finland, I first introduced my research to people at Aalto University (Figure 3). There, I got a lot of questions and suggestions mainly from a theoretical point of view. That was an eye-opener for me, because I mostly considered my work from an experimental point of view. Then, together with some of the researchers, I tried to solve an optimization problem for DNA self-assembly: the tile concentrations problem. The problem is to find a set of concentrations of DNA strands that construct a shape of DNA structure in the shortest possible time. We found a conjecture[1] that the tile concentrations problem is #P-hard in computational complexity theory. Currently, we are trying to prove the conjecture. In parallel, to design DNA self-assembly, I tried to characterize a relationship between the binding speed of DNA strands (i.e. the assemble time) and the DNA sequence. That will enable us to design the self-assemble path way using the DNA sequence. For this purpose, we analyzed my experimental data for DNA binding (or hybridization) using a machine learning method developed by researchers in Aalto University. Now, the machine learning experiment is running.

My daily life in summer in Finland was very comfortable. It was cool and dry, so it's very suitable to do research activities. I enjoyed studying under the plentiful sunlight. Also, Finnish people were my good English teachers. Their mother tongue is Finnish or Swedish, but they speak English fluently and clearly. Their English was very easy to hear for me. Some

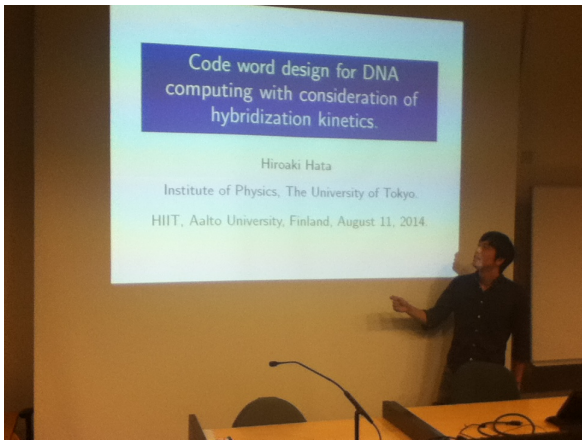

Figure 3: My talk in the Helsinki Institute for Information Technology HIIT seminar.

Figure 4: Conference excursions to islands of Turku, the oldest city in Finland.

[1] Adleman, L., Cheng, Q., Goel, A., Huang, M.-D., Kempe, D., de Espané, P.M. and Rothemund, P.W.K. (2002) *Combinatorial optimization problems in self-assembly. Proc. thiry-fourth Annu. ACM Symp. Theory Comput. - STOC '02*, 10.1145/509909.509913.

conferences and meetings were held in Finland during my stay. I attended a conference of computer science (Descriptional Complexity of Formal Systems) with my supervisor. Figure 4 was taken at the conference excursion. At the conference, I met many people and we talked about many things on a boat until sunset (the sunset didn't come until after 11pm). That was a rewarding experience for me. I also attended meetings of Japaneses researchers working in Finland. I had a most useful and helpful discussion about researches and carrier paths there.

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