

# Research Visit to Tokyo Institute of Technology

## 1 November–2 January 2023

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## 1 About Tokyo Institute of Technology

Tokyo Institute of Technology<sup>1</sup> (東京工業大学) is a university with a history of over 140 years. It is the top university for science and technology in Japan<sup>2</sup> with three campuses located across Tokyo, Japan. The university continues to expand, and it is currently in the process of incorporating Tokyo Medical and Dental University<sup>3</sup>. The process is expected to complete in October 2024, and Tokyo Institute of Technology will change its name to Institute of Science Tokyo (東京科学大学) to reflect these changes.

At the time of writing, more than 10 000 students are enrolled in bachelor's, master's, and doctoral degree programs. The university consists of 20 departments organized into six schools<sup>4</sup>: School of Science, School of Engineering, School of Computing, School of Materials and Chemical Technology, School of Life Science and Technology, and School of Environment and Society. Tokyo Institute of Technology is thereby active in a wide area, including topics like robotics, development of solar cells, and of course computing. As such, Tokyo Institute of Technology is similar to the Technical Faculty at Linköping University.

## 2 Research Visit

After my PhD defence in May 2023, I started considering future directions for my research. As such, I found and reached out to several researchers that had recently participated in computer science education conferences. One of the people who answered was Youyou Cong, who is a part of the Programming Research Group<sup>5</sup> led by Hidehiko Masuhara at the Mathematical and Computing Science department. At the time, Youyou Cong was in the process of developing a new course on delimited continuations for master's degree students. As a part of this work, she was considering what languages and tools were available to illustrate the complexities of continuations, and the sometimes subtle differences between different approaches. Due to my experience with program visualization and my interest in programming languages, I was happy to help with the project. We were able to meet briefly and discuss some further details in the summer of 2023 when I went to Japan with a couple of friends on vacation.

During the summer and the first part of autumn, me and Youyou Cong managed to get all the paperwork in order for me to visit in the beginning of November 2023. When I arrived, we were quickly able to get started on the project. Youyou proposed using the programming

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<sup>1</sup><https://www.titech.ac.jp/>

<sup>2</sup><https://www.titech.ac.jp/english/about/overview>

<sup>3</sup><https://www.titech.ac.jp/english/news/2023/068065>

<sup>4</sup><https://www.titech.ac.jp/english/0/education/departments>

<sup>5</sup><https://prg.is.titech.ac.jp/people/cong/>

language Pyret<sup>6</sup> as a teaching tool. Pyret is a functional language designed explicitly for novices by the PLT group at Brown University, USA. As such, it provides helpful error messages, and an intuitive online IDE that is convenient to use as a starting point. The downside, however, was that it did not support continuations. After getting familiar with the codebase, I managed to implement a proof-of-concept library that added continuations to the language. Luckily, I was able to re-purpose the existing support for arbitrarily sized execution stacks to implement continuations with relative ease. This was a very useful exercise for my understanding of continuations. Without it, and the helpful advice from Youyou Cong, I would not have understood some of the finer nuances in the differences between different types of continuations.

After the proof-of-concept, we continued to design and implement custom syntax for the new concepts in the language. This proved easier said than done due to the design of the existing compiler. With some effort, we have now reached a point where we have the features needed for the aforementioned course. This includes integrating the modified language into the online teaching system for Pyret. What remains is to adapt the available tools to illustrate continuations. At the moment, the implementation of a *stepper* is underway, and we hope to be able to implement some other form of visualization as well. Sadly, we did not manage to complete the project by the end of the visit in January. We are, however, still planning on finishing the project (although, both me, Youyou Cong, and a PhD student, Kazuki Ikemori have been quite busy since January). The goal is to have a usable language when Youyou Cong's course starts in June this year, and collect data and experiences from that and publish our results. In the meantime, Youyou Cong has also started working on a paper that details the language itself that we will hopefully be able to finish by the end of the year.

Apart from the research project, I was also invited to participate in a number of other activities. At Tokyo Institute of Technology, all students join a lab in the last year of their four year bachelor's degree. Students who pursue a master's degree continue to work in the lab during their studies. During this time, students collaborate with one of the professors in the lab to work on various research projects. Each week, the lab organizes two seminars, where a student presents their current research project. From this, I was able to get a fairly good view of the area the lab operated in. Apart from these seminars, I was also invited to attend another series of seminars called *research project*. This is essentially a small course where the lab teaches the topics they work on, in the hopes that some of the attending students will eventually choose to join the lab. The topics of these seminars were functional programming and continuations. This was very relevant for me, as it gave me a better insight into the mathematical side of computing through untyped and typed lambda calculus, which is the formalisms upon which continuations I was working with are defined. The system of having students do research at a lab also made me remember hearing about a method called VIP<sup>7</sup> that could be used at Linköping to increase student involvement with research in a similar way. The visit inspired me to look further into trying this approach at Linköping.

Finally, I was also invited to attend a workshop-like event called NII Shonan Meeting<sup>8</sup>, where researchers from around the world gather and discuss a pre-determined topic. In this case, the topic was software visualization. Youyou Cong was initially invited, but were unable to attend due to other obligations. As such, she proposed that I attend instead due to my work during my PhD. The meeting turned out to be an excellent opportunity to meet new and interesting people, and gave me even more ideas for future research directions. One of the attendees from the event recently reached out to me and asked if I wished to be a program chair for a conference in Lund later this year. I took the opportunity, and also submitted a paper to the workshop.

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<sup>6</sup><https://pyret.org/>

<sup>7</sup><https://www.vip-consortium.org/>

<sup>8</sup><https://shonan.nii.ac.jp/>

In summary, my main takeaways from my visit were that I met and got to speak to interesting people (Youyou Cong and Hidehiko Masuhara, but also many others). Since both are interested in different areas of language design, I feel like both can provide valuable feedback on the feasibility of ideas I have been thinking about exploring. They are working in areas that I am unsure if we have at Linköping. Apart from this, I gained valuable insights into the more mathematical side of computer science and language design. Again, an area that I have not seen too much at Linköping. The project with Youyou Cong is still moving forwards, and will likely turn into at least two publications eventually. She also expressed interest in visiting Linköping in the future. Finally, the ideas from the program visualization community have also inspired me with possible venues for future research.

### 3 Visiting Japan

Japan is a nice place to visit, both on a research visit like mine, and as a tourist. Based on rumors about the work-life balance in Japan, I was initially worried about long work days. This did, however, turn out not to be the case in academia as a visiting researcher at least. The workload for the professors in the lab also seemed to be roughly equal to Sweden. Tokyo Institute of Technology also has dedicated housing for foreign researchers that is located right next to campus. Apart from the closeness to campus that means you can avoid the crowded trains during rush-hours, it was also cheap compared to other alternatives. With the exchange rate during my stay, the rent was roughly 4 500 SEK a month, including utilities (i.e., garbage disposal, electricity, gas, and water). Aside from housing, the cost of living in Tokyo is roughly the same as in Sweden. Certain groceries, such as fruits, are more expensive while others are cheaper. In particular, eating out is overall cheap compared to Sweden. In particular, there are many options on the cheaper side that do not have the typical unhealthy fast-food feel.



Figure 1: View from my office during my time at Tokyo Tech. On clear days Mount Fuji was clearly visible.



Figure 2: Visit to the old capital Kamakura during the excursion of NII Shonan Meeting.



Figure 3: Christmas lights with Tokyo Tower in the background during an evening in December.