

Personal Data

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Executive Summary

In the travel schedule, I write about trip plan from Chitose to Leuven and from Leuven to Delft. It takes more than 12 hours to go from Chitose to Leuven. And so, I was very tired.

In the Research section, I write the topic in Leuven. This topic is based on Neural Networks. This back ground is the realization of the autonomous machine by using Spiking Neural Networks. First of all, I need to study about Neural Networks, especially Spiking Neural Networks. And, I investigate what another university and research organization done in the world. Next, I examine some simulators about Neural Networks. And then, I choose 1 simulator and simulate on the base of the data from an autonomous invalid chair sensor. At last, we can indicate the superiority of the specific neural network to compete each other by the simulation.

In the Exchange life, I explain living in Leuven. First of all, I introduce my residence. This was very nice residence. And I have precious experience there. Next, I describe the laboratory life in the weekdays. And then, I showed what I have done in the weekends. At the last paragraph, what I have felt about the prices is written. Some of them are expensive, but most of them are cheap.

In the Suggestion for the project, I wrote my opinion towards the students who will apply for this project and organizers. First of all, I thank to participate in this project. But, it is too short time to research and stay. It's better to stay long time in one university. And I also write about scholarship. It is enough for me. I can enjoy my Leuven life with the amount. And I explain about Belgium. What it is usual in Japan is unusual in Belgium. I have got a lot of culture shock.

Travel Schedule

Chitose-Leuven

City	Date	Time	Airline	Flight time
Chitose	20/09/04	07:45	NH 3122/Y	1H30
Narita		09:15	*1*	Non-stop
Narita	20/09/04	12:20	LH 715/H	12H15
Munich		17:35		Non-stop
Munich	20/09/04	19:00	LH 5892/H	1H20
Brussels		20:20	*CL*	Non-stop

NH: ALL NIPPON AIRWAYS LH:LUFTHANZA GERMAN AIRLINES
OPERATED BY:
 CL LUFTHANSA CITY LINE
 1 FAIR INCORPORATED

A PhD student came to the Brussels airport and he brought me to Leuven by car.

Leuven-Delft

City	Date	Time	Train
Leuven	04/02/05	11:12	IR
Mechelen		11:30	
Mechelen	04/02/05	12:11	IC 611
Rotterdam		13:38	
Rotterdam	04/02/05	13:45	2244
Delft		13:58	

Research

In Neural Network, there are many kinds of network. For example, Perceptron, Recurrent network, Hopfield network, Kak networks, Spiking Neural Networks etc... Among all of them, Spiking Neural Networks are similar to human real brain and, not complicated but easy to compose. So, we can apply that to vision recognition or some functions of the brain with ease. Furthermore, we can embed that to portable devices (for example, Khepera, blimp) and make new machine like the autonomous air-plane which Dario Froleano have made. For the purpose of that first of all, we need to know how neural networks works, what kinds of simulators are published. Next, we use simulators of these and compare another Neural Network. And, in the future we will use real machine to solve a problem.

First of all, I had to study about neural networks: Recurrent networks, especially Spiking Neural Networks. The Spiking (or pulsed) Neural Networks (SNNs) are models which explicitly take into account timing of inputs. The network input and output are usually represented as series of spikes (delta-function or more complex shapes). SNNs have an advantage of being able to continuously process information. SNNs are often implemented as recurrent networks. Networks of spiking neurons - and temporal correlations of neural assemblies in such networks - have been used to model figure/ground separation and region linking in the visual system. And I also choose another Neural Networks to compete with SNNs. These are Back propagation and SCG.

The former is the most popular algorithm. This is a technique used for training neural networks. It is most useful for feed-forward Neural Networks (networks that have no feedback, or simply, that have no connections that loop). The term is an abbreviation for "backwards propagation of errors".

$$\Delta_{w_{ij}} = \eta \delta_j o_i$$

$$\delta_j = \begin{cases} f'_j(\text{net}_j)(t_j - o_j) \cdots \text{if unit } j \text{ is an output - unit} \\ f'_j(\text{net}_j) \sum_k \delta_k \omega_{jk} \cdots \text{if unit } j \text{ is a hidden - unit} \end{cases}$$

η : learning factor eta (constant)

δ_j : error (difference between the real output and teaching input) of unit j
 t_j : teaching input of unit j
 o_i : output of the proceeding unit i
 i : index of a predecessor to the current unit j with link ω_{ij} from i to j
 j : index of the current unit
 k : index of successor to the current unit j with link ω_{jk} from j to k

The latter is also a supervised learning algorithm for feed-forward Neural Networks, and is a member of the class of conjugate gradient methods. They are general purpose second order techniques that help minimize goal functions of several variables, with sound theoretical foundations. Second order means that these methods make use of the second derivatives of the goal function, while first-order techniques like standard back propagation only use the first derivatives. A second order technique generally finds a better way to a (local) minimum than a first order technique, but at a higher computational cost. Like standard back propagation, SCG iteratively try to get closer to the minimum. But while standard back propagation always proceeds down the gradient of the error function, a conjugate gradient method will proceed in a direction which is conjugate to the directions of the previous steps. Thus the minimization performed in one step is not partially undone by the next, as it is the case with standard back propagation and other gradient descent methods.

Next, I investigated what they have done about SNNs in the world. And, I also analyze the simulators for Neural Networks. In the end I choose one simulator among what I have researched and I simulate Neural Network. This simulator is SNNS. SNNS (Stuttgart Neural Network Simulator) is a simulator for neural networks developed at the Institute for Parallel and Distributed High Performance Systems (IPVR) at the University of Stuttgart since 1989.

And so, we analyzed those data for the simulation of autonomous machine. When the invalid chair goes on a road which sometimes has obstacles, that one needs to pass over. If the driver can control that chair, we don't need to think about this. But, if the driver cannot make that move at all, people have to help them. However, people do not stay together all time. And so, that chair has to judge. The purpose of an autonomous invalid chair is to get round

a barricade by itself. We use neural network to get a solution of this problem.

This data comes from an autonomous invalid chair sensor. The data has 36 values (1 value is time, another is from sensor) as an input. And this has 1 output. The output returns 0 or 1. The input values are not 0 or 1 but numbers less than 10 including minus.

There are many possibilities which how many units are appropriate. For example, this should be the number same as the input units, the output units, the average of the input units and the output units and so on. How to decide the number of hidden layer is not established certainly. This is almost determined by an experience. But, in this Simulator pruning functions are available. So, at first, we prepared same units as an input layer for a hidden layer. And we tried to make neural networks smaller and more effective.

We use two algorithms for pruning. One is called "non-contributing units" and another is called "Magnitude based pruning". The method of the former uses statistical means to find units that don't contribute to the net's behavior. The net is subdivided into its layers, the output of each neuron is observed for the whole pattern set and units are removed that

- don't vary their output,
- always show the same output as another unit of the same layer,
- always show the opposite output of another unit of the same layer.

The Later is the simplest weight pruning algorithm. After training, the link with the smallest weight is removed. Thus the saliency of a link is just the absolute size of its weight. Though this method is very simple, it rarely yields worse results than the more sophisticated algorithms.

And, we prepare these data;

- Input 35 units (B:39, D:30)
- Hidden 35 units(temporarily)
- Output 1 unit
- Pattern file A : 2074 pattern
- Pattern file B : 4336 pattern
- Pattern file C : 1634 pattern
- Pattern file D : 1353 pattern
- learning cycles for first training : 1000

And, from those data we can get those results;

The number of units after pruning

Pattern file	"Non-contributing units"		"Magnitude based pruning"		Note
	Input	Hidden	Input	Hidden	
A	35	19	31	30	
B	35	24	35	35	!!
C	35	22	35	35	!!
D	35	33	30	10	

!!: In "Magnitude based pruning", we cannot get the number in hidden layer because the simulator can not generate those values.

The value of MSE after training by learning function

Pattern file	Standard Back Propagation	SCG
A	0.00079	0.00291
B	0.00818	0.00415
C	0.00185	0.00123
D	0.00237	0.00000

MSE is defined as a next equation.
$$MSE = \frac{SSE}{n - p}$$

- n = Number of observations (sample size)
- p = Number of parameters, to be estimated (weights)
- SSE = Sum of squared errors

First of all, B and C have many various patterns. And so, about "Magnitude based pruning" they cannot be settled. On the other hand, D has many similar patterns. So, they can make neural networks easily and the number of the hidden layer becomes very few. But, about "non-contributing units" the number of hidden layer of A is less than that of C. So, though, some of them cannot settle the number of units, others can decrease the number of units. About learning function, the value of B is most in all the patterns. This depends on too many patterns. Only "Standard Back Propagation" of A has more MSE than "SCG". "SCG" of D is most suitable learning function. But, you can see all the patterns get a good result.

But, we were also going to simulate SNNs and compete with another Neural Networks. However, we could not do it because of less time. So, in the future we can do it.

Exchange student life

First of all, I want to introduce my surroundings. I lived at the apartment. In this apartment, many international students lived. There, a shower, a kitchen, and a toilet are shared with the inhabitants. So, I met them at the kitchen every day. And I was able to make some friends and sometimes went to a bar with them or exchanged the typical dinner of own country. So, though I lived in Leuven which is far away from Sapporo I don't feel lonely at all.

Next, I explain the laboratory. It takes 15 minutes from my residence by bike. This laboratory is very big to compete with the Japanese laboratory. Some professors work there. My supervisor is Professor. Nuttin. He had me do what I want to do. But, this laboratory does not have private computers enough to use whenever I want. So, I need to bring my lap top computer every day.

In weekdays I go to the laboratory and in weekends I and my friends meet and sometimes travel a Belgium city or drink at a bar or eat dinner. A lot of international students from all over the world come to Leuven for study, internship and so on. People from Spain are more than those from any other countries except for Belgium. And I thought 2nd biggest community is Chinese community. By the way, Leuven is very small city so, whenever I went out, I certainly met a friend. It was very interesting and exciting thing. And, most of inhabitants in Leuven are students. Their age is very similar to my age. So, I can easily make friends and get along with each other.

The prices of the most things in Leuven are lower than those in Japan. For example, I can buy a sandwich for 2.5euro at a student restaurant. On the other hand, cloths, shoes, and computers are more expensive than the products which I can get in Japan. An exchange student usually cannot do a part time job. So, I get all my money from only this scholarship. But, it is enough. The residence fee costs 285 euro per month. The food expenses cost approximately 10 euro per day. And, when I go to Brussels in the weekend, it costs 4.6 euro to buy the weekend ticket: the return ticket which you can use only on Friday, Saturday, and Sunday.

Suggestions to the Project

- It is not enough time to stay in Leuven for only 5 months. The research was finished in the way. So, I hope the students for long period stay in 1 university for long time next year.
- When I talked with foreign students, they definitely asked about Japan. For example, Japanese attitude toward United States, traditional cloths, history and so on. So, the students should know much about Japan.
- A semester of Europe usually starts in September. Before a semester starts, there is an orientation days: To help you get settled during your first few days in Leuven, a special program with useful tips and information, and opportunities to meet your fellow students. And so, in order to attend that, the students should go to Leuven before starting an adjustmental meeting.
- I needed a lot of money during first few days in Leuven. This amount is almost 100,000 yen. So, I suggest the students get the first scholarship before going abroad.
- When I do anything, I need to speak in English. So, the English skill is highly necessary. If possible, the students should study Dutch spoken in Leuven. And so, they can communicate with Belgium people more.
- I looked for a residence after arriving at Leuven. Because it was told that I could find a residence easily. But, it is difficult to find a cheap place. At first I went to International Housing Office, this is an organization of KULeuven for the accommodation. But, they told me that rooms they have are already full. Next, I went to another private office of housing. But, they also told me same things. In the end, I got a room from a poster in the university. So, the students are strongly advised to come to Leuven as early as possible in order to arrange their permanent housing.
- When I went to Belgium for study, I needed to get a visa. In order to obtain a visa, I needed some documents and a passport. It takes at least 1 month to prepare these things. So, if the students are decided, they should behave earlier as long as they can.
- In Leuven most of shops and restaurants are closed on Sunday. And there is no convenience shop which is open for 24 hours every day. So, the students need to buy something to eat before Sunday. Otherwise they have trouble

Summary

I stayed 4 months and 2 weeks in Leuven. It is definitely precious time for me. And so, I want to thank to this project, coordinators, supervisors, and my laboratory mates.

When I arrived to Leuven, I felt what an old town is! It looks like a one scene in a movie of the Middle Ages. Actually, Leuven has many old buildings of world heritage and is surrounded by walls like a ring.

But, at the same time I felt culture shock. In the weekends all the shops are closed. It was very inconvenient for me. Because it is first time to live abroad and to go to Europe, and I got used to the Japanese style which some shops are always open every day. So, I always worried about the meal of the weekends, especially Sunday.

The research topic is a little different from the topic in Japan. At first, my topic was about reconfigurable robot. I researched at this topic for a while, and it was getting more and more boring topic more for me. And so, I talked with my supervisors and they permitted to change the topic. This new topic is about Neural Networks. And I am more interested in Spiking Neural Networks. So, I researched at this topic, but I could not simulate by using Spiking Neural Networks. I regret that thing.

Many international students from all over the world live in Leuven. And their age is very similar to my age. So, I could easily make friends and get along with each other. It is very fun and valuable experience. And I was able to know their culture, for example, traditional cooking, clothes, events and so on. I think I also know what Japan is seen by the foreign countries. They told me Japan is rich, high-technology country, very funny behaviors for Europeans and so on. Actually, it is difficult to know real Japan in Europe. Because it is very far away and broadcast stations hardly make a program of Japan. But, I also felt I don't know much about Europe. What they, European are usual is not usual for me. I think if you live abroad you can get it. So, it is an irreplaceable experience.