Report of the NII IAB Meeting 2017

Prof. Wolfgang Wahlster (Chair),

Prof. Randy Goebel, Prof. Antoine Petit, Prof. Calton Pu, Prof. Wen Gao

19 November 2017

Introduction

This is the report of the 2017 meeting of NII's International Advisory Board (IAB), which took place on October 26 and 27 in Tokyo. The program of the meeting can be found in Appendix A. Two of the participants of the last IAB meeting in 2015 attended the current meeting (Calton Pu, Wolfgang Wahlster). The other three members of the IAB were newly recruited personalities with a very broad topical coverage and wide geographical distribution.

This report contains general observations and specific comments and recommendations on the positioning and strategy of NII, the research program, management and organization, industry engagement and the organization of the IAB. The report summarizes the consensus opinion of the entire IAB.

General Observations

2017 is NII's 5th year under the directorship of Professor Kitsuregawa. The Institute is flourishing along all dimensions. In our view, the very positive development of NII since the last IAB meeting in 2015 is not only based on the management skills and the excellent network of the Director, but also on the fact that he is an active, internationally recognized researcher in important areas of Informatics like Data Bases, Big Data, and Data Mining, and is thus serving as a role model for NII researchers.

It is important to note that NII is the only national institute in Japan that is completely focused on Informatics. The research agenda of NII is of central importance to the Japanese strategy towards Society 5.0, which integrates cyber space and physical space to generate new societal value from Super Smart Services. Key elements of a service platform for Society 5.0 are now being developed by NII. We are happy to see that current research at NII includes almost all relevant topics of modern informatics.

Professor Kitsuregawa and the entire staff of NII are to be congratulated on the significant scientific progress that has been made since the last IAB review in 2015. The IAB is pleased to observe that the concerns and recommendations from the last IAB report have been clearly and successfully addressed.

Although NII had to cope with another annual decrease of 1% of its general expenditure as part of the operating subsidy provided by the Ministry of Education, Culture, Sports, Science and Technology (MEXT), Prof. Kitsuregawa and his team were able to increase the overall NII budget to an all-time record for 2016 by development and execution of a very successful external project acquisition strategy.

In particular, the almost fourfold increase in income from commissioned research from important companies like NTT, Hitachi, NEC, Sumitomo Mitsui bank and IBM (from 46 Million in 2013 to 194 Million in 2016) is very impressive and shows the economic and societal impact of NII's research

results. The IAB encourages the increase of academia-industry collaboration in innovations centers like the Cognitive Innovation Center supported by IBM, and the new FinTech Center on smart financial data, headed by the Director General of NII. The use of automated information gathering and content extraction to turn big data into smart data with real application value for increased revenues is a very important activity in the new stream of NII's innovation activities.

Such innovation activities in partnership with industry are now being introduced as part of a third pillar of NII's mission for societal and industrial impact. The IAB commends the creation of the third pillar with various efforts supported by resources acquired from new sources, beyond the traditional NII budget. First, the closer cooperation with industry should be encouraged, for example, the cognitive innovation and financial smart data research center. These new centers provide the basic research departments with new demands for theoretical investigations, and helps focus the infrastructure and service departments by exposure to large-scale societal and industrial IT challenges. Second, the creation of various open access research infrastructure platforms, including a repository of medical imaging data (in collaboration with AMED) and software tools for managing experimental research data (in collaboration with several international open science initiatives), is an invaluable effort. The IAB notes that these activities of the third pillar successfully build on and leverage the synergy between the research excellence at NII (first pillar) and the shared service supporting scientific research (second pillar).

Positioning and Strategy

As an Inter-University Research Institute, NII has become a springboard for advanced academic and industrial research careers, developing young researchers in an environment of research excellence to their full potential and helping them to get positions at prestigious research institutions in Japan or abroad. For example, the young group of researchers in the large graph project headed by Ken-ichi Kawarabayashi has filled 16 assistant and associate professorships at top universities like University of Tokyo and Kyoto, in addition to 14 industrial research positions, just during the last two years 2015 -2017.

The tremendous increase in the number of reports about NII in the media is very remarkable. In 2016, there were now close to three times more reports in the public media than in 2013. This has increased the value of NII as a brand name recognized worldwide for outstanding research and innovation in Computer Science.

Given the increasing contributions of NII to cyber infrastructure (e.g., SINET5) that have enabled ground breaking scientific research (e.g., high energy physics), and its effective support for more than 800 research and educational institutions, the IAB believes that it is of critical importance for NII to assume a larger role. This can be achieved by elevating the NII from a Research Organization of Information and Systems (ROIS) to the status of Inter-University Research Institute Corporation, comparable to the High Energy Accelerator Research Organization (KEK). In addition, the IAB has recognized the need for more space for NII in the National Center for Sciences Building or its immediate neighborhood, since the current space limitations are a serious impediment to the NII growth strategy.

We commend NII for taking a broad digitalization perspective and to embrace emerging fields, combining core computer science with other disciplines in an interdisciplinary fashion. The IAB is happy to see that current research at NII covers a wide range of relevant topics of modern informatics and is able to adapt in a timely manner to new research trends like deep learning, open science and data platform, financial smart data processing, blockchain technologies, and advanced cybersecurity research.

The IAB recognizes and applauds NII's efforts on improved gender balance with 20% female professors, and on increasing the number of young researchers under the age of 42 to 32% in 2017.

The international focus is particularly impressive and should be commended. The new office established by JETRO and NII in San Francisco creates a two-way bridge between the NII ecosystem and the Bay Area ecosystem. It can become a cradle of innovation for NII and the companies cooperating with NII. We recommend contact and collaboration with other international hubs of research close by in San Francisco, like the EIT Digital Hub of the European Institute of Innovation and Technology, which is representing many European research organizations such as INRIA, DFKI or Imperial College collaborating with NII based on MoUs. This will strengthen NIIs ecosystem via the inflow of ideas, technology, start-ups, and investments, with activities clustered around innovation and entrepreneurship.

The milestone of 100 NII Shonan Meetings, which provide Dagstuhl-like seminars for the world's best 30 researchers on specific research topics in computer science, have now established a platform for the international exchange and collaborations of NII faculty with their peers and should be continued and increased in frequency.

Research

It is not surprising that the breadth of the research and service spectrum of NII offers many existing and emerging opportunities to exploit machine learning, both in research projects, and in the development and extension of NII services (including adaptive traffic management in SCINET5, and meta data capture and exploitation in CiNII).

Emerging service support areas (Medical Image Big Data Analysis, Open Science, Judicial Reasoning, Security Operations) can all exploit some aspects of machine learning, as they are data intensive, and provide the opportunity for either contributing to decision making (e.g., medical and judicial decision-making), or to support the identification of preferred best practices (e.g., in overall network security, and workflow in the management of data and processes for Open Science).

The identification of security challenges and the development of systems to disrupt homogeneous surveillance in support of privacy have the constant challenge of anticipating how machine learning is used for facial recognition. As high performance deep neural systems do not require pre-identification of high value attributes for recognition, the development of facial recognition defeating devices will require constant update.

In addition, the continual evolution of the overall SINET5 infrastructure exposes the opportunity to explicitly identify and exploit a classification hierarchy of both aggregate and individual users, so as to improve dynamic network management and improve guaranties on quality of service (QoS).

The Visual Media Group, like all such research groups world-wide, is vulnerable to the rapid advancement of visual media processing using deep learning. They have embraced this challenge by using a variety of machine learning methods to support a layered architecture of image and vision processing that focuses on the integration of conventional and machine learning methods, to provide specific and measurable improvements in multi-perspective image synthesis, video object recognition, underwater imaging, and simulation of liquid flow dynamics for graphics.

The voice cloning project encompasses a variety of machine learning techniques to both improve speech synthesis overall, and to support a variety of applications, including the capture of historical individual speech models (e.g., for animation dubbing from deceased human voices), the development of natural speech production in the case of speech disability or trauma (e.g.,

restoration of normal speech for those with speech damage), and in a variety of human interaction applications, to help retain attention in interaction by using familiar voices. However, we recommend comparing the results with the Lyrebird system (https://lyrebird.ai/) which claims to clone a voice with only one minute of audio. The newest work on capture and use of speech prosody is very interesting, but demonstrates the need for incorporating speech dialog semantics to be able to find alignment with appropriate prosody patterns.

We commend NII on having hired the PIs of two of the extremely competitive JST ERATO grants, which have an acceptance rate of 0.1% only. This shows the scientific excellence of researchers at NII in Large Graph Theory and Metamathematics for Systems Design and has brought $15M for five years of external funding. The new ERATO project, Metamathematics for Systems Design headed by Ichiro Hasuo, aims to apply formal methods to build cyber-physical systems (CPS) with guaranteed properties through formal methods. The main approach is to create meta-models for classes of applications, and then prove theorems on meta-models that will apply to the entire class. The approach appears to be innovative within the area of formal methods, but it may have the same limitations of all formal methods, since the complexities of real world CPS applications often exceed and escape the rigid assumptions necessary in a formal framework. The IAB felt the project could benefit from an exploration of techniques beyond formal methods (e.g., big data analytics on detailed event logs) to take into account both guaranteed properties when assumptions are true (within a formal model), and extended properties when assumptions do not hold (beyond formal models).

Within the last two years, the advisory board has witnessed a continuing increase in the influence, output and scientific impact of NII, and we are very pleased with the number and quality of publications at top international conferences and journals. However, the academic visibility could be increased even more curating and providing open access to annotated big data sets as information extraction challenges, training material for machine learning or benchmarking, that are shared with the worldwide academic community. As a further step, research results could be packaged into software systems that are free for use in academia and become standard reference tools for research experiments.

The IAB members had intensive discussions based on 13 poster presentations for 90 mins. Every IAB member visited at least 5 posters in parallel with the other members. The poster session was a good format for in-depth technical discussions about some of the important research highlights at NII. Detailed comments from the IAB are included in Appendix B.

Academic Information Infrastructures and Services

One of the original missions of NII is providing cyber infrastructure services for academic institutions, primarily universities. This mission includes the SINET5 (the primary academic internet service for Japanese universities), and various services built on SINET. The SINET is a 100Gbps backbone network for 850+ universities and research institutions, with a total of estimated 3 million users. SINET has a mesh topology and provides significant quality of service properties, including high bandwidth (99 Gbps in Japan and 150 Gbps between Japan and USA) and low latency (173 msec RTT between Tokyo and New York, 161 msec RTT between Tokyo and London). SINET survived significant disasters such as the 2016 Kumamoto earthquake. The IAB considers SINET to be a significant achievement, and applauds its continued development and evolution to provide essential services for Japanese academic institutions.

A vision for SINET6, which is planned for 2022, is under development. For real-time remote process control in industry (physical avatars), clinical surgery, traffic management and research, as well as

advanced augmented and dual reality applications, networks with guaranteed latency will become a necessity. The so-called next generation Tactile Internet requires RTTs of less than 10 ms both on networked and wireless internet connectivity. The IAB recommends the exploration of collaborations with European and US institutions working on this topic.

Additional services provided by NII include:

•	Cloud gateway: GakuNin cloud interface to all major public cloud service providers in Japan, including value-added services such as free data load for AWS.

•	CiNii: Search service for Japanese research information (e.g., articles and dissertations); it links to several repositories and digital libraries, servicing about 60M queries in 2016. When there was a service disruption for 2 weeks, there were about 10.000 messages of users complaining that their academic work is massively disturbed by the lack of CiNii access. This shows that CiNii is a critical infrastructure for academia in Japan, so that its resilience is of major importance.

•	JAIRO: cloud repository for Japanese academic institutions.

•	Security infrastructure and services: security appliances to collect attack data, security data analytics, notification of attacks, user personnel education and cooperation.

The security services provided are of enterprise quality, with no major breaches reported since the beginning of SINET5 (April 2016). A major development is the availability of attack data to be made available to security researchers through academic data exchange programs. The statistical data about attacks and the large amount of malware samples being provided by NII may become very important assets for cybersecurity researchers worldwide. Thus, the IAB fully supports this major NII initiative.

It was a very clever decision of NII's management to establish SOCS for Security Operation Collaboration Services in its Center for Cybersecurity Research and Development, since there is an increased need to protect academic freedom but at the same time fight cyber-attacks challenging the critical academic infrastructures. The education and training for university staff on cybersecurity that is provided by NII-SOCS is of ultimate importance. In the first test phase during March – June 2017 already 460 critical alerts at 74 participating universities have been analyzed. The statistical data about attacks that are opened to the public by NII without IP addresses and timestamps as well as the large amount of malware samples are a very important asset for cybersecurity researchers.

The IAB recommends continued study on the hot topic of usable security and privacy. Many of the privacy and security problems that plague today's online world are the result of a failure of system designers to consider their intended users, so that the human factor of not using or even switching off security technologies becomes a major concern. More basic research is needed on human behavior and related risk, to understand how people make decisions about their privacy and security, how they interact with privacy and security mechanisms, and ultimately how to design computer systems that result in improved privacy and security outcomes.

Organization of the IAB Meeting

The IAB thanks the staff of NII for the excellent preparation and organization of the meeting as well as the great hospitality. It was very good to have the opportunity to interact with many researchers during the poster session and the reception, in addition to the plenary presentations. In addition, the joint dinner with NII's management team on the evening before the start of the plenary sessions was very helpful for general strategic discussions about the future plans of NII.

The poster session should be enhanced by live system demonstrations of prototypes in the labs of the NII research groups or in a demonstration room.

However, the overall format of the meeting was almost perfect and should be retained for the next meeting. It became clear that a smaller number of IAB members allows more interactive discussions compared to previous meetings. However, the time for the closed-door meeting of the IAB on the last day should be increased to 2 hours for the preparation of the draft report. It was an improvement over 2015, that there were no parallel workshop sessions. The extended duration of the meeting till 3.30 pm on the second day was an additional improvement.

Appendix A

International Advisory Board Meeting

Thursday October 26– Friday October 27

Room 1901-1903, 19th floor

IAB Members:

- Professor Wolfgang Wahlster, CEO of DFKI, (Germany), Chairman

- Professor Wen Gao, Vice-President of the national Natural Science Foundation of China, Peking
University (China), participated partially via teleconference

- Professor Randy Goebel, Associate Vice- President for Research, Alberta University (Canada)

- Professor Antoine Petit, CEO of INRIA (France)

- Professor Calton Pu, Co-director of Center for Experimental Research in Computer Science, Georgia
Institute of Technology (USA)

Wednesday October 25

18h00-20h00 dinner at Niwa Hotel hosted by Director General Masaru Kitsuregawa with IAB
members.

DAY 1 (Thursday October 26)

09h45-10h00 Coffee

10h00-12h00 General Introduction of NII by Director General Masaru Kitsuregawa

12h00-13h00 Lunch, bento box

13h00-16h00 Introduction of NII research activities: presentation by NII researchers

1. Professor Ken-ichi Kawarabayashi

Introduction to Large Graph Project: We are all young, but doing well!

2. Associate Professor Ichiro Hasuo

Formal methods for cyber-physical systems: on JST ERATO Metamathematics for Systems Design
Project

3. Professor Isao Echizen

Security and privacy challenges at border between cyber and physical worlds

4. Associate Professor Junichi Yamagishi

Recent advancements in cloning voices

5. Professor Shin'ichi Satoh, Professor Imari Sato (from Italy)

Activities of Visual Media Group at NII

16h00 -17h30 Poster session Room 1208, 12th floor

18h00 -20h00 Buffet Get-together: Josui Kaikan: IAB members and NII researchers

DAY 2 (Friday October 27)

09h15- 9h30

09h15- 9h30 Coffee

09h30 -10h30 Activities of the Academic Information Infrastructure by Professor Shigeo Urushidani, Professor Kento Aida and Professor Hiroki Takakura

10h30 -11h30 Integration of Informatics Research and Services by Professor Kazutsuna Yamaji and Professor Kento Aida

11h30-12h30 General Discussion

12h30-13h30 Lunch, bento box

13h30-15h00 IAB members closed session Room 2107, 21st floor

15h00-15h30 Presentation of comments/suggestions of IAB members

Appendix B

The IAB has the following comments and recommendations for the projects presented at the poster session:

1. Associate Professor Mahito Sugiyama: Tensor Balancing on Statistical Manifold

An efficient algorithm to solve matrix balancing, a generalization of matrix balancing using Newton's technique, was presented. Several examples are used to show the pertinence of the approach. The proposed method is claimed to be also suitable for various statistical and machine learning models. The limits of the proposed approach and thus its possible extensions have now to be studied.

2. Associate Professor Masako Kishida, Resource-aware controls for networked systems

This presentation described a novel factoring of manufacturing control systems, by decoupling modeling (of a manufacturing facility) and the use of model predictions to improve the general development and deployment of control signals. This factoring positively exposes the opportunity for exploiting machine learning to improve manufacturing control.

3. Associate Professor Yiuichi Yoshida: Constant Time Algorithms

The work on constant-time algorithms is first class and will also have a great practical importance in the future for applications where one needs only a rough judgement of far-away negative compliance on solution constraints. His brilliant paper "An improved constant-time approximation algorithm for maximum matchings" at STOC is still highly quoted.

4. Assistant Professor Ryota Kobayashi: Event time series analysis and its application to Web and neuronal data analysis.

Of particular note was the breadth of Kobayashi's knowledge, especially in the modeling and analysis of signals produced from rats and monkeys with neuronal probes. The methods of time series analysis are clearly demonstrated to be of value in both domains, and are relatively easy to communicate to experts in both domains.

5. Assistant Professor Yochi Iwata: Theoretically and practically fast algorithms for exploiting structures

Iwata's clever identification and factoring of subgraph structure (e.g., sub-graph width) is not only theoretically predictive for significant algorithmic improvements, but he has also demonstrated empirical improvements in a number of algorithmic challenge problems.

6. Assistant Professor Kazunori Sakamoto: Smart Motivator: A Learning Smartphone Application with Personalized Motivational Methods

This work appears as a first interesting step. It will now be useful to develop a comparison with the existing literature, in particular with the objectives to strengthen the proposed method and to be able to generalize it. In the journal "User Modelling and User-Adapted Interaction" - various similar and more elaborate approaches have already been presented.

7. Associate Professor Megumi Kaneko: Spectrum & Energy-Efficient Wireless Communications for Future 5G/IoT Systems

This theoretical work aims at the definition of protocol communications in future 5G systems with a better efficiency concerning spectrum use and energy consumption. The first results are promising.

We now recommend investigation of their scaling-up and study of generalizations of the hypotheses made.

8. Associate Professor Kenji Tei: Models@run.time for Self-adaptive systems: A Controller Synthesis-based Approach

The learning of environment models is very important for autonomous systems. The proposed differential learning method is quite efficient with a good runtime learning rate in changing environments. However, the robustness of the methods must be tested in a real application.

9. Associate Professor Yusuke Miyao: Natural Language Processing to Bridge Heterogeneous Data

Miyao has refined his knowledge and systems for semantic parsing to transform images and image sequences into a semantic description that can be used as a semantic annotations to classify (and retrieve) images and short videos. This will be of significant value in the overall systematic curation of multi-modal data, including images, video, and language descriptions.

10. Associate Professor Takayuki Mizuno: Big Data and supply chain management: Exploiting global buyer-supplier networks to improve supply chain due diligence

The improvement of the supply chain due diligence by data mining and information extraction technology is an important contribution that should be enriched by the analysis of data streams from social networks and coupled with sentiment analysis by labs like Sociovestix. In addition, the SD4M system described in "Real-Time Discovery and Geospatial Visualization of Mobility and Industry Events from Large-Scale, Heterogeneous Data Streams" see the ACL-16 Proceedings should be taken into account.

11. Professor Isao Echizen: (1) PrivacyVisor: Method Based on Light Absorbing and Reflecting Properties for Preventing Face Image Detection; (2) BiometricJammer: Use of Pseudo Fingerprint to Prevent Fingerprint Extraction from Camera Images without Inconveniencing Users

The PrivacyVisor has already been presented two years ago and not much academic progress except design improvements have been shown. We recommend to conduct an empirical market analysis, since as soon as the function of these glasses to hide the identity of the wearer becomes known, law-enforcement agencies may be attracted by the wearer. It was also questioned whether organized crime or terrorists may become the main customer of such devices. In addition, since face recognition is now also done by end-to-end deep learning CNNs working on the pixel level, it is not clear, whether the PrivacyVisor can still disable face recognition for these new methods. The BiometricJammer was new, but the use of pseudo fingerprints as camouflage was not completely convincing from a usability point of view.

12. Associate Professor Hitoshi Okada: On the Governance of Blockchains without an Authority and under an Authority

The Blockchain is a subject of increasing interest with a lot of potential applications. The proposed approach seems interesting but it suffers from a lack of comparison with the already existing published results. More convincing applications would also be welcomed, in order to show the pertinence of the suggested approach.

13. Professor Helmut Prendinger: Unmanned Aircraft Systems Traffic Management

The 85 Million yen NEDO project for three years on the traffic management infrastructure UTM for swarms of small drones for logistics or surveillance is very ambitious. The demonstration of the pre-

flight and in-flight collision avoidance software of unmanned aircraft systems was very impressive and forms the basis for the safe deployment of UAS solutions in the future.