

# **Evaluation of the Research and Professional Activity of the Institutes of the Czech Academy of Sciences (CAS) for the period 2010–2014**

## **Final Report on the Evaluation of the Institute**

**Name of the Institute:** Institute of Mathematics of the CAS, v. v. i.

**Fields, in which the Institute registered its teams:**

Computer and information sciences

Observer representing the Academy Council of the CAS: Jan Šafanda

Observer representing the Institute: Tomas Vejchodsky

### **Commission No. 2: Computer and information sciences**

Chair: Professor Edwin Hancock PhD, DSc.

Date(s) of the visit of the Institute: November 23 - November 25, 2015

Programme of the visit of the Institute: see attached Minutes from the visit

Evaluated research teams:

*No. 5 - Logic and Theoretical Computer Science*

## **A. Evaluation of the Institute as a whole**

### **B.**

#### **1. Introduction**

It is in principle very difficult to evaluate the whole Institute based on evaluation of a single working group. Generally, the Institute appears as a top scientific institution to the Computer Science Committee. This assessment is based both on the excellent results and position of the evaluated group and on the summarizing institutional information obtained preliminarily in written form and complemented during the Prague meeting.

#### **2. Strengths and Opportunities**

The Institute has a firm position as the leading mathematical theoretical institution in the Czech Republic and is highly recognized internationally. Besides being strong in the more classical branches of mathematical theory, it is also breaking into new areas which extend into other fields, such as theoretical computer science, physical or biological mathematics, all of which are treated at a high level. This interdisciplinarity, together with rich international contacts, collaborations and mobility, provides new opportunities for the theoretically oriented institute. The ability to obtain prestigious grants contributes to stability of the institute. The existing collaboration with universities is obviously mutually profitable.

#### **3. Weaknesses and Threats**

Although the present age structure is rather satisfactory, it appears difficult to recruit young researchers (PhD students, postdocs) due to complicated formalism of relations with universities. The financial stability is negatively influenced by the short-time grant system and non-competitive salaries that also hinder hiring top researchers from abroad.

#### **4. Recommendations**

From the limited view of this commission, we can recommend to follow the strong traditions of the institute. To these traditions belongs in particular the institute's role in applied numerical mathematics and in modern computational science. This is exemplified by its contributions to the theoretical foundation of the finite element method. Finite elements have become a central pillar of many computational methods and are nowadays used universally in those disciplines that use predictive computational models. This means that work originating at the institute is being applied in virtually all fields of engineering and science. This heritage should be valued highly and should be developed (even more) actively into the future.

#### **5. Detailed evaluations**

**Declaration on the quality of the results and share in their acquisition:** *only for the single department evaluated - see below.*

**Declaration on the involvement of students in research:** *only for the single department evaluated - see below.*

**Declaration on societal relevance:** *only for the single department evaluated - see below.*

**Declaration on the position in the international and national context.** The Institute appears as a high-level institution in its fields, well comparable with the top world level and with a high international recognition. Numerous international cooperations and international mobility supports this view. In the national scale, the institute is obviously recognised as the leading institution.

**Declaration on the vitality and sustainability.** The institutional scientific staff has basically satisfactory age structure and the high professional qualification namely of its senior members is undoubted. Almost a quarter of the staff are foreigners. The institute offers both the PhD study and postdoc positions for young researchers, however the recruitment is hindered by the complicated administrative rules on the study that is controlled by universities. Funding of the institute is based – besides of the institutional background – on many national and international grants, including very prestigious ones. Considering the high-level publishing output, the funding is effectively utilised. The stable scientific position of the institute promises a reasonable funding stability based on grants even for future. The management of the institute, including the career system, is standard, determined by national legislation and the rules of Academy, and may be considered adequate.

**Declaration on the strategy and plans for the future.** The research strategy of the Institute, reflecting the world status of the respective theoretical areas, corresponds to the present trends in the respective fields. The available means – human resources, infrastructure and financing – appear adequate for realisation of the plans.

## **C. Evaluation of the individual teams**

### **Evaluation of the Team No. 5: Logic and Theoretical Computer Science**

#### **1. Introduction**

The research by the team is concerned with complexity theory and related areas of mathematical logic and theoretical computer science. The research is of the highest quality, with the majority of the submitted outputs rated as world-leading. This makes this an outstanding team.

#### **2. Strengths and Opportunities**

The team performs theoretical research of outstanding quality across a range of areas including computational complexity and proof complexity, generating also a substantial grant income. The proportion of outputs ranked as world-leading is impressive. Opportunities arise from the fact that Charles University has also started hiring researchers in complexity theory, which makes Prague an increasingly attractive location for this research area, with potential benefits e.g. in the recruitment of post-docs and PhD students.

#### **3. Weaknesses and Threats**

The team is vulnerable to researchers leaving the team, moving either to universities in the Czech Republic (for better access to students) or abroad (for higher salaries). In the reporting period, 4 researchers have left the team, but could fortunately be replaced by 3 new researchers. However, if further researchers leave the team and cannot be replaced, this would be a real risk. Salaries not being competitive also makes it difficult to attract top researchers from abroad. Furthermore, limited access to students makes it difficult to recruit sufficiently many strong PhD students.

#### **4. Recommendations**

Maintain the high level of research quality, and exploit opportunities arising from the increasing presence of complexity theory research at Charles University. Perhaps also aim to increase international collaboration by attracting leading experts as visiting researchers.

#### **5. Detailed evaluations**

**Declaration on the quality of the results and share in their acquisition.** The research efforts were focused on studying the complexity of computationally hard problems and the development of approximate algorithms for their solution. Major achievements and new results were obtained in proof complexity, bounded arithmetic, non-classical logic, set theory, online algorithms, databases, control theory, and other subjects. The total number of outputs is 139 with 71 of them included in the WS. Given an average annual personal capacity of 7.4 FTE for researchers and 0.3 for other workers, the productivity of the department can be considered very good. The quality of the publications, as assessed in Phase I, is excellent with a Quality Profile median value of 1 (world leading) and an average of 1.4. Based on the AIS journal ranking, the quality of the publication venues is very good with 3 papers appearing in a journal ranked in the top decile and 23 papers appearing in a

journal ranked in the upper half. The contribution of the team to these publications is significant. The outstanding quality of the work is internationally highly regarded, but because of the prevailing publication and citation culture of the subfield this is not revealed by the bibliometric indicators provided.

**Declaration on the involvement of students in research.** The department hosts several PhD students working on individual topics within the range of research that is conducted by the institute. As it is characteristic of the work in the institute, the research is organized as tasks pursued by individual students, no specific forms of interaction and collaborative work are being promoted.

**Declaration on societal relevance.** The research at the institute is of a fundamental theoretical nature whose societal impact can only be indirect. However, the group is involved in graduate-level teaching at the Charles University, where it puts on specialist graduate courses on advanced topics. The group regularly contributes similar courses to graduate-level summer schools and advanced study institutes, and at universities outside the Czech Republic. There is also a relatively small amount of scientific popularisation activity within the group, but the institute as a whole has a significant and quite innovative commitment of this type of activity.

**Declaration on the position in the international and national context.** The international reputation of the team is very high, as shown e.g. by membership in editorial boards and conference program committees. The award of a prestigious ERC Advanced Grant further demonstrates the high quality and international reputation of the research. Results are being published at highly selective top conferences of the field (including STOC and FOCS) and in leading journals, at the same quality level and with comparable impact as other internationally leading groups (that are often larger than this team). The team covers a breadth of research topics that is wider than one would typically expect from a team of this size.

**Declaration on the vitality and sustainability.** The age distribution of the group is generally healthy, with the majority of researchers in the range from 25 to 45 years (although the small number of researchers in the range from 45 to 65 years might potentially lead to a lack of experienced research leaders at some point, so it is important that the young researchers are prepared for taking on more senior leadership roles in the future). The team is able to attract foreign PhDs and post-docs and also has two foreigners among the researchers. The volume of grants acquired by the team is substantial and larger than one would expect from a team working in theoretical areas. The team is well managed.

**Declaration on the strategy and plans for the future.** The research topics that the team plans to pursue in the future build on its strengths and are timely and relevant to current developments of the field. The team is in a strong position to realize the plans.

**Date:** December 21, 2015

**Commission Chair:** Professor Edwin Hancock PhD, DSc.