Evaluation of research and professional activity of research-oriented institutes of the Czech Academy of Sciences for the period 2015–2019

Summary Final Report

Name of the Institute:

Institute of Information Theory and Automation of the CAS, v. v. i.

Evaluated teams and their leaders:

1. Department of Adaptive Systems (Tatiana Valentine Guy)

2. Department of Control Theory (Sergej Čelikovský)

3. Department of Decision Making Theory (Martin Kružík)

4. Department of Econometrics (Jozef Baruník)

5. Department of Image Processing (Barbara Zitová)

6. Department of Pattern Recognition (Michal Haindl)

7. Department of Signal Processing (Jiří Kadlec)

8. Department of Stochastic Informatics (Jan Seidler)

Part A: Evaluation of the institute

Strengths:

The Institute has a diverse portfolio of research. Some areas are producing significant and internationally competitive research. Members of the institute are involved in a wide range of national and international projects and collaboration internationally is very good. The policies and procedures for staff are very effective and HR management is good. The age structure is well-balanced and the Institute should be commended for its gender balance. The buildings and facilities for staff are excellent, including an extensive library.

Weaknesses:

A recurring problem with the Teams constituting the Institute is fragmentation into small and sometimes inactive subareas. As a result, effective co-operation between Teams and team-members seems to be hindered. It is clear that, in a number of Teams, the research undertaken is not reflected in its name, which seems to be a historical artefact. There are no effective mechanisms at the institutional level for addressing these problems, and the central organization and the pace of change in the Institute could be improved. Some of the work in the Institute is related to work in ICS, but there does not seem to be much cooperation or coordination of the research between the institutes. Some of the Teams are not producing outputs with a high level of impact. The arrangements for PhD students are not ideal in terms of the legal position in the Czech Republic and the significant failure rate in PhD study is concerning.

Opportunities:

There is a substantial body of research in the general area of AI within the Institute of Computer Science and in the Institute of Information Theory and Automation; coordination of the research in this area could lead to a more substantial and effective program of research.

Computer vision and AI are very dynamic areas which are rapidly expanding, and there is an opportunity to explore new directions which can both produce excellent research and attract industry funding. Reorganization of the research in the Institute could lead to new impetus in some areas and a clearer external profile.

Threats:

It is clearly more difficult to attract top research talent to the team because of the financial conditions and the short-term nature of many grants is not helpful. There is a danger that the best researchers will not want to work in the team. This is amplified by the strong demand for skills in some research areas may make it difficult to appoint and retain good researchers.

Main criterion: 1. Quality of results (H1.1-H1.5)

H1.1	Quality of selected outputs of Phase I
The institute handed in 145 selected outputs in Phase I and achieved the following distributions of ratings	

1	2	3	4	1 or 2
15,9%	42,8%	31,7%	9,0%	58,6%

1 „world leading", 2 „internationally excellent", 3 „recognized internationally" 4 „recognized acceptable"

There are some areas which have a strong set of outputs and others which are weaker. The overall level of selected outputs is competitive nationally and a little below the level of the best institutions internationally.

The result of the assessment of the selected Output in Panel I as well as its evaluation in Phase II (see topic D1.1) lead to the conclusion that the Institute can compete with the best international institutes in most of its field.

H1.2	Contribution of workers on the outputs reached

Most papers in this area have a small number of authors, typically three or less with many single author papers. The contribution is therefore significant in all these outputs.

H1.3	Quality of all outputs and results

The full quality profile fits the same pattern as the phase I selected outputs. The overall number of outputs is good. Publications are often in pure mathematics journals or computer science proceedings, for which bibliometric data such as impact factors and citations are misleading.

H1.4	The most valuable discoveries and findings in the fields, their importance for the field

Work on the theory of large scale and networked systems.

The articles in SIAM Journal on Optimization (2016) on Lipschitz condition for multifunctions, SIAM Journal on Mathematical Analysis (2018) on the characterization of Young measures, and IEEE Information Theory (2016) on entropy region and convolution stand out as important theoretical results.

The works on fundamentals, algorithms, and applications of Moment Theory. The works on a number of image processing problems including deblurring and recently tracking are highly recognized.

The modelling of BRDFs, with particular application to their perception and comparison. The measurement of BRDFs.

Theoretical results on stochastic PDEs, and theory of particle systems. New algorithms for tensor decompositions.

H1.5	Contribution of the participation of the authors in large collaborations

There is an excellent level of international involvement in large collaborations. This is evidenced by some 17 international funded projects and involvement in two large national centres. This has led to a large number of internationally co-authored papers.

Main criterion: 2. Societal relevance (H2.1-H2.5)

H2.1	Societal relevance of outputs and results pursuant to CAS and institute mission

The institute is a mixture of both theoretical and highly applied research. While the societal relevance of the more theoretical work is not direct, there are some applied areas where the work is immediately relevant to societal issues. ZOI are involved in image forensics, cultural heritage and medical imaging. Pattern Recognition studies the appearance and perception of materials. Signal processing develops commercially relevant embedded systems.

H2.2	**System functionality for knowledge transfer into practise, its usefulness for society. The impact of the institute´s activity on proper practice in society in the area of social sciences and humanities**

There are no specific arrangements for knowledge transfer at the institutional level, for example no technology transfer office. It is part of the general remit of the vice-director for management. Main responsibility of instigating these activities seems to fall to department heads and individual researchers. This may work well for teams with strong commercial contacts, but less well for other teams.

H2.3	**Relation to practice**

Of all the institutes to be assessed by the Commission, this one has the most groups and projects in which the direct transfer of research results into practice is pursued intensively and with success. On the one hand, this comparatively strong practical orientation strengthens the importance of the institute. However, it also brings with it additional problems that are also experienced by other institutions that pursue application-oriented basic research and direct transfer into practice. These result from the different requirements in the two areas, also in the quality criteria. The Institute is facing up to this well-known problem and its approaches to solving it are largely successful.

H2.4	**Participation in AV21 strategy**

There is active and significant involvement in AV21. One program is coordinated by UTIA („Hopes and Threats of the Digital Era") and this has led to some significant research initiatives and interesting collaborations outside the Institute. Two workshops were organized within the program.

H2.5	**Cooperation with regions of the Czech Republic**

Although there does not seem to be a specific plan for regional cooperation, there is some significant regional activity through normal research activities. These include joint projects with regional universities, PhD accreditation, teaching and the national research centres.

Further criterion: 1. Position in international and national context (D1.1-D1.3)

D1.1	**Comparison of the teams and the institute with similar international and national institutes**

In its scientific programme and structure, the Institute is oriented as a centre for both

- application-oriented basic research
- the transfer of advanced mathematical and computational methods to a broad spectrum of real-life problems.

In the sciences, including social sciences and humanities, in medicine, engineering and industry in a broad sense. It is mainly structured methodologically, i.e., the teams also integrate the application areas, except for the Department Stochastic Informatics, which is currently just focussed to the further development of stochastic theory and statistical methods.

Due to the rapid development in computer systems and information technology, which in turn also built on advances in mathematics and computer science, many computational science departments, institutes and centres have emerged internationally in recent decades. UTIA can be considered as such a centre. When classifying it, its historical development as an institute of the CAS must also be taken into account. It is on all levels well embedded into a network of national and international partners pursuing similar aims in research and its

transfer, partially also in education. In a good proportion of its activities, it is also most successful in national and international competition. (See also topic H1.1) Its historical name, the Institute of Information Theory and Automation, is only partially helpful in classifying its goals and program.

D1.2	**Scope and quality of international and national cooperation and the role of the institute in such cooperation; engagement in broad international cooperation**

The Institute has an important national and international position in most of its scientific areas. Its teams are well embedded in international networks of experts. It also has built up good connections to industry and business, and also established direct cooperation with international leading companies. It seems that the connections altogether have now reached such a scale that focusing on them could even benefit quality and effectiveness.

D1.3	**Participation of the workers in scientific community activities (organizing of conferences and workshops, invited lectures, awards)**

Several of the staff are intensively and decisively involved in such activities and thus make an important contribution both to the scientific community and society, but also to their institute, whose position nationally and internationally is thereby enhanced.

The large number of scientists at the Institute, the achievements of distinguished national and international awards, the fact that many are in demand as invited speakers at congresses and as guests of renowned universities and centres, also is in agreement with the rating of the Institute obtained in the Panel.

Further criterion: 2. Vitality, sustainability and strategy (D2.1-D2.9)

D2.1	**Direction in line with the perspective of the planned research directions**

The planned research directions basically do not deviate from the central focus of the institute. The healthy dynamics of an institute like UTIA actually should also include flexibility, which is required because of the progress of research. From an overall perspective, it can be confirmed that the teams of the Institute have largely chosen their research objectives appropriately.

D2.2	**Assessment of the previous research objectives and their achievement**

The previous research goals were set according to the actual goals of the institute. Perhaps more focus and coordination between the teams would have been appropriate. These were current issues at the front of research. They were largely balanced between basic research and applied research. As far as can be judged from the available documents, the specific research objectives set were achieved to a reasonable extent.

For the evaluation of the results achieved, reference is made to the evaluation of the outputs, insofar as they record the results. However, the proper value of results achieved will sometimes only be able to be adequately assessed with a time delay, especially if they are strongly application-related.

D2.3	**Assessment of implementation of recommendations from past evaluation**

The Institute was evaluated in the past evaluation by 4 commissions covering altogether the disciplines involved in its program. Their recommendations addressed mainly similar topics, listed and commented (marked with*)

1. Focusing and integrating the scientific program of some of the teams

   There is currently a need for action in this topic.

2. Improving the cooperation of teams within the Institute and with teams of other Institutes of CAS

*Cooperation within the Institute itself has been improved in some cases, but the potential that still exists needs to be better utilised. This also applies in part to cooperation with other institutes with related sub-disciplines.

The ongoing cooperation in A21, in which UTIA is very strongly involved, is very successful and deserves high credit. The cooperation within. Necas Center for Mathematical Modelling needs to be strengthened

3. Separation of the basic research and application activities

* Some teams tried an adequate differentiation in the structure of projects. This seems appropriate at first. However, in addition to some advantages, disadvantages for the scientists affected by the differences also emerged.

4. Allocation of stable resources, necessary for long time projects and for continuity

* Improvements could be achieved on this topic.

5. Improvement of the decision process at the Institute level, establishing an International Advisory Board.

* So far, no significant changes can be seen on this topic.

D2.4	**Success in receiving grants**

The Institute has been very successful overall with numerous grants to secure the necessary resources for its staff, equipment and the implementation of its programme and its ambitious goals. The major part of this funding came from the following institutions:

Czech Science Foundation GACR, European Commission EC, Ministry of Education, Youth and Sports MEYS, Ministry of Industry and Trade MIT

Ministry of the Interior MI, Technology Agency of the Czech Republic

D2.5	**Adequacy of instrumental equipment**

The institute seems to be perfectly equipped and to offer an efficient service.

D2.6	**Effectiveness of management**

The institute is clearly structured. It depends on a well-functioning management in order to achieve its ambitious goals in research, teaching and transfer of research as a large, internationally positioned institution.

However, up to now it lacks a scientific advisory board, staffed with highly qualified internationally renowned experts, whose advice is especially important for planning and decisions that strongly affect the further development of the institute. Experience shows that purely internal processes rarely lead to the best solutions, neither a purely inside bottom up, top down or mixed approach.

D2.7	**Assessment of professional structure, development strategy and the strategy of keeping best scientists, age structure, career and qualification growth**

The Institute's scientists know that early contact with talented students and a link between teaching and research are important to renew and secure the long-term structure of the scientific staff and the quality of research.

In the discussions of the Commission with the current PhD students at the Institute showed that good education associated with the institute is a very good advertisement for the institute and step for recruitment. Giving young researchers a free hand in research in good time often leads to innovations, especially in the Institute's strongly represented disciplines of mathematics and computer science. The Institute offers talented scientists very good prospects and, because of the combination of application oriented basic sciences with transfer to direct applications, also a choice between different careers.

However, a prerequisite for this is a good balance between basic research and applied research and minimising the pressure of project research, which is necessary to secure the necessary resources.

D2.8	**Creating work-life balance conditions, assessment of approach towards possible gender issues**

The Institute is exemplary in the care and provision of its staff. Gender equality is fully implemented in all areas.

D2.9	**Relation of the institute with regard to the integration, development and sustainability of the research centre funded by the National Programme of Sustainability II.**

Not relevant.

Further criterion: 3. Cooperation with universities and participation in education (D3.1-D3.6)

D3.1	**Scope of cooperation with universities on national and international level**

The Institute is strongly involved in education Czech and foreign universities at universities. Its members:

deliver per year about 100 semestrial course,

supervise about 50 PhD students with contract (usually partial time),

    about 50 PhD students without contract,

supervised about 300 students in the Master- and Bachelor program.

There are jointly accredited PhD study programs of UTIA in particular with Charles University practically in all disciplines represented in the research program of the Institute.

These activities are a substantial contribution both to education and promoting the aims of the Institute.

In the discussions with all the institutes to be assessed, it became apparent that there are still existing obstacles to effective cooperation with universities, the elimination of which requires measures to be taken at a higher level.

D3.2	**Effectiveness of joint research centres**

Institute participates in the research joint laboratory SALOME2 together with the partner University of Economics, Faculty of Management (FM). However, no concrete activity is documented in the institute report.

D3.3	**Success rate in supervision of PhD students**

The figures cited in D3.1 indicate that the Institute contributed substantially and with success to the education of PhD [RW1].
A more precise determination of the success rate required a more detailed analysis, for which the necessary data are not available.

[RW1] The documentation notes a significant failure rate of PhD students

D3.4	**Participation of PhD students in the outputs**

Experience shows that good doctoral theses make important contributions to progress in the sciences, which is also true for this institute. In general, it can be assumed that the Institute's teams adhere to the rule: Whoever makes a significant contribution to research findings will

also receive an appropriate share in the publication. This assumption is also supported by the Institute's goal of involving talented young researchers in research as early as possible.

D3.5	Participation of the institute in master or bachelor studies

The figures cited in D3.1 indicate that the Institute contributed substantially also to the education of bachelor and master students.

D3.6	Assessment of cooperation intensity with universities in the form of teaching

According to the existing circumstances, the potential was used with success. Improving the existing conditions in the cooperation with the universities could increase their efficiency even more.

Further criterion: 4. Outreach activities (D4.1-D4.3)

D4.1	Sufficiency of media strategy and activities in the area of research popularisation

The institute has been very successful in promoting science in various ways, e.g. organizing of "Open House "events, active participation in the "Science and Technology Week" and the annual "Science Fair".

D4.2	Publishing activities and its quality

A major editorial activity of the institute has been the publishing of the Kybernetika. This journal publishes research results in control sciences, information sciences, system sciences, signal and image processing, statistical decision making, applied probability theory, random processes, operations research, fuzzy and uncertainty theories, and closely related fields.

The current impact factor of Kybernetika is 0.664.

D4.3	Participation in professional organisations in the area of research and development

The teams were responsibly involved in the planning, organisation and implementation of international workshops and conferences with current topics from their research area. This commitment is to be evaluated positively.

Comments and recommendations of the Commission

There is some concern in the Commission about the overall direction and organization of research, at the level of the Institute. The Institute emphasizes academic freedom, but complete freedom can lead to fragmentation of research topics and very small research subgroups. In some of the teams, there seems to be a wide range of topics and little overall plan. It is necessary for the Institute to exert some overall control over research strategy, and we recommend an overall review and planning exercise to establish a coherent plan for future research and organization of the Teams. Defunct topics should be curtailed and the names of Teams changed where appropriate to reflect their scientific focus.

The Institute lacks a scientific advisory board, staffed with highly qualified internationally renowned experts, whose advice is especially important for planning and decisions that strongly affect the further its development The Commission repeats this recommendation already made in the last evaluation.

A number of Teams engage in research which can be broadly categorized as AI, both in UTIA and Computer Science. There could be significant gains to be made by cooperation and coordination in this area, but there is little evidence of interactions between these research teams even within the Institute. We recommend that the Institutes involved in this area consider some kind of more formal framework for collaboration in this area.

A focusing of research on topics that are in line with the central objectives of the respective team is recommended. Since the titles of some teams do not reflect sufficiently their real orientation, this deficit should be eliminated.

It is recommended that the Institute strengthens cooperation with teams at other CAS institutes and regional universities in sub-disciplines in Mathematics and Computer Sciences, to the benefit of research and teaching in these areas. In this context, participation in institutions such as the Necas Centre offer good options.

The Institute works in a number of areas such as medical imaging, forensics and security, where ethical considerations are important. The Commission was not presented with evidence that these issues are fully addressed. There should be an ethical committee to oversee this area, and if one does not exist, the Institute should consider setting one up.

The funding model of the Institute means that external funding is critical for the sustainability of research. Some more formal support for preparing and submitting grants should be considered, for example some dedicated staff to work in this area.

The arrangements for PhD students are not ideal and still a cause for concern. The students do not formally undertake their degrees with the Institute and this makes it very difficult to assess the quality of the education. For example, it is not clear that failure rates are tracked for the students that work at UTIA, or whether they receive any skills training. It does not seem that the formal position will change, but at least information about length of degree and failure rates should be evaluated.

Other comments of the commission:

Part B: Evaluation of teams

1. Department of Adaptive Systems

Strengths:

The Department of Adaptive Systems is distributed over a large research area. The research of the team covers at least 6 topics, with some subtopics. The team was for decades involved in fundamental research and developed new concepts, algorithms software and applications. Many of the new scientific results are published in highly impacted Journals and Proceedings

Weaknesses:

Cooperation of team members is difficult if too many topics are selected. Focus of attention is needed. At this moment the theoretical research and application are loosely connected.

The group is limited in size and needs more staff members. To start the defined new research directions, additional experienced staff members are needed. An increase in postdocs, PhD students is recommended.

Integration of applications in theoretical development could be considered. The research on AI, with decision making agents should play a more prominent place.

Opportunities:

The broad research areas and topics offer many opportunities for innovative research. The topics are of interest for many researchers in National and International research Institutes. This offers a lot of opportunities for cooperation. Given the long year experience of members of the group, they might take the lead in National and International research projects. The team has some excellent researchers, which could apply for different kinds of grants.

Threats:

To be active in many research areas, may result in a small operating research sub-group.To attract new projects and funding it is necessary to focus on a limited set of research topics for some years. The teams show some clusters of research activities around active researchers. Cooperation in International groups enlarged the research capacity, but it should be guaranteed that the knowledge and expertise remains within the group.

Main criterion: 1. Quality of results (H1.1-H1.5)

H1.1	Quality of selected outputs of Phase I		
The team achieved the following distribution of ratings			
1	2	3	1 or 2
13,3%	50,0%	30,0%	63,3%
1 „*world leading*", 2 „*internationally excellent*", 3 „*recognized internationally*"			
The selected output is good in quality. The total output of the team is good in quality and quantity.			

H1.2	**Contribution of workers on the outputs reached**

All workers contribute significantly to the outputs. But the distribution of papers is not uniform. Some researchers have a much higher output and can be considered as the scientific engines of the group. Some PhD students start with a publication in a conference proceedings and continue with publications in impacted Journals.

H1.3	**Quality of all outputs and results**

Members of the group published their results in high impact journals and also in Conference Proceedings.

H1.4	**The most valuable discoveries and findings in the fields, their importance for the field**

The research is distributed over 6 topics. The topics are split up in subtopics. In the areas of most of the topics the group presents innovative results. Many results are published. But the research is very distributed and should be more focussed in the next future. Researchers in the section applied mathematics are supposed to cooperate with colleagues in the Academy.

H1.5	**Contribution of the participation of the authors in large collaborations**

Members of the team were active in two application-oriented projects, within the Eurostars Programme and Czech-Norwegian Research Programme. Regarding fundamental research, the team was active in a COST Action funded project.

The team was not yet involved in other European projects or cooperations, they didn't find new projects or were leading researchers in European projects. Many individual members of the team participated in International cooperation and were many times leading authors of joint publications.

Main criterion: 2. Societal relevance (H2.1-H2.5)

H2.1	**Societal relevance of outputs and results pursuant to CAS and institute mission**

Members of the team invest a lot of time and effort in societal relevant applications. The educational effort is big with respect to the size of the group. One of the new research topics are social networks. This research needs high performance computing facilities next future, which are not reported.

H2.2	**System functionality for knowledge transfer into practise, its usefulness for society. The impact of the team´s activity on proper practice in society in the area of social sciences and humanities**

Decision making processes play an important role in society on many areas and levels. The team selects special applications to apply their theoretical based research findings. The team is supervising many BSc and Master thesis work, which are supposed to focus on practical applications.

H2.3	**Relation to practice**

With respect to applications, the major concerns of the team are distributed monitoring in industrial projects and safety critical decision making.

H2.4	**Participation in AV21 strategy**

The program AV21 is focussed on socially relevant research. Artificial intelligence plays an important role and is one of the research activities of the team.

H2.5	Cooperation with regions of the Czech Republic

Members of the group cooperate in an informal way with many colleagues from abroad and less with colleagues in the country. The limited size of group doesn't allow extensive activities in different parts of the country.

Further criterion: 1. Position in international and national context (D1.1-D1.3)

D1.1	Comparison of the team with similar international and national institutes

Members of the team are selected based on their knowledge and expertise to participate in a huge International project. Members of the group cooperate with colleagues from renowned European Universities.

D1.2	Scope and quality of international and national cooperation and the role of the team in such cooperation; engagement in broad international cooperation

The group has a limited size. But a team of researchers is part of EU-COST Action CA 16228. There is a long list of cooperating colleagues abroad. Most of these cooperative activities resulted in common papers.

D1.3	Participation of the workers in scientific community activities (organizing of conferences and workshops, invited lectures, awards)

Two members of the group are in the Board of scientific organisations and members of the International Conference committee. Other members take part in local scientific boards. The group organised yearly a conference and/or workshop. Members of the group were invited for some lectures at Universities abroad. Two members were awarded with the Otto Wichterle Award, an honour of the Academy of Sciences to stimulate young researchers.

Further criterion: 2. Vitality, sustainability and strategy (D2.1-D2.9)

D2.1	Direction in line with the perspective of the planned research directions

In the report there is a detailed list of planned actions and research activities for the next future. For the implementation of new research topics, additional resources and researchers are needed.

D2.2	Assessment of the previous research objectives and their achievement

The research plan was focussed on continuation of the current research topics and establishing new research directions. The newly defined research directions got a promising start including a newly established application. One application has been terminated not to reduce research topics but because a vital member of the group was leaving.

D2.3	Assessment of implementation of recommendations from past evaluation

In the previous evaluation it was stated that the team should focus on fewer and better defined research topics. The research topics are now better defined, but there are still too

many topics. This is mainly caused by the fact that there have been more new topics than the abandoned ones.

It was recommended to apply for international grants. Application for a big international grant was not performed. Several Czech Science Foundation grants and an Inter-Excellence projects were awarded. The team participates in a large scientific network in the COST framework. In the future the group should make efforts to apply for funding from highly competitive European funding schemes (e.g. FET).

D2.4	Success in receiving grants

The members of the team did not apply for an International grant, because time and funding were too limited. The team obtained several local awards. A positive is that ten project proposals were funded including two international projects.

D2.5	Adequacy of instrumental equipment

No details are provided about the planned extension of computing resources. Especially implementation of the planned research in social media requires new computing facilities.

D2.6	Effectiveness of management

The management supports a friendly working environment. There is an increase of involvement in students´ activities. Attracting new personnel has been delayed. Attracting new personal has been delayed. Attracting new personal, including international researchers has been partially successful (Prof. Rezunenko and Prof. Quin).

D2.7	Assessment of professional structure, development strategy and the strategy of keeping best scientists, age structure, career and qualification growth

The HR policy is in line with the policy of the Institute. Members of the group are relatively young, 14/20 members are younger than 45 years. The HR section focuses on equal opportunities in promotion and development of scientific careers. The management supports different professional and personal development of the team members.

D2.8	Creating work-life balance conditions, assessment of approach towards possible gender issues

The team supports personal and group developments and takes care that there is no discrimination with respect to gender, race and age.

D2.9	Relation of the team with regard to the integration, development and sustainability of the research centre funded by the National Programme of Sustainability II.

No information provided.

Further criterion: 3. Cooperation with universities and participation in education (D3.1-D3.6)

D3.1	Scope of cooperation with universities on national and international level

Members of the team are involved in many teaching activities at Universities. A list of cooperating partners at Universities abroad is provided in the team documentation.

D3.2	Effectiveness of joint research centres

Cooperation with researchers abroad resulted in many joint publications.

D3.3	Success rate in supervision of PhD students
Members of the group (co-) supervised an increased number of PhD students. But the number of successfully defended PhD theses in the period is still low (5).	
D3.4	**Participation of PhD students in the outputs**
The involvement of PhD students in research activities and scientific output was increased.	
D3.5	**Participation of the team in master or bachelor studies**
Members of the team gave lectures at technical universities and polytechnics, including the Czech Technical University, University of West Bohemia, University of Vienna, Trinity College Dublin, Kharkov National University.	
D3.6	**Assessment of cooperation intensity with universities in the form of teaching**
Members of the team gave many lectures with a focus on the Czech Technical University.	

Further criterion: 4. Outreach activities (D4.1-D4.3)

D4.1	Sufficiency of media strategy and activities in the area of research popularisation
Members of the team delivered lectures on popular topics and seminars for non-professionals. The team also participated in Open House activities and the Exhibition Science fair. Also students from secondary school were supervised in open science projects. Members also delivered popular lectures in several gremia.	
D4.2	**Publishing activities and its quality**
No publishing activities of Journals or books/lecture series are reported.	
D4.3	**Participation in professional organisations in the area of research and development**
Team members take part in scientific boards of universities and research institutes.	

Other comments of the commission:

2. Department of Control Theory

Strengths:

Small homogenous Team with national and some international recognition capable of carrying out excellent research in specific research directions. Strong relations to educational institutions are an advantage.

Weaknesses:

The size of the team does not allow expanding collaborations towards industrial partners or to diversify the research to other interesting directions in order to achieve more practical outcomes. The number of projects is limited by the research capacity of team members and does not allow submitting a higher number of national and international proposals.

Opportunities:

The removal of the weaknesses mentioned above indicates the Team's opportunities for diversification of the research directions and thus for the expansion to applications of Control Theory. This will enhance the Team's sustainability and strengthen its national and international recognition as well as open up additional sources of financial support from industrial partners.

Threats:

The Team depends on the expertise of a few researchers with different specialisations. Loss of senior team members for whatever unpredictable reasons may be an issue for the sustainability of the Team.

Main criterion: 1. Quality of results (H1.1-H1.5)

H1.1	Quality of selected outputs of Phase I
Quality of outputs of Phase I are slightly above average with 1 world leading (FC=1) and 6 excellent (FC=2.53) outputs out of 15. Increase of the output quality would definitely influence the performance of the Team in a positive way.	
H1.2	**Contribution of workers on the outputs reached**
Many of the contributions of team workers resulted in outputs with lower quality. Strengthening of international cooperation may have a positive influence on quality and number of outputs in the future.	
H1.3	**Quality of all outputs and results**
The overall quality of all outputs and results may be considered as average. Of the 15 outputs evaluated in Phase I, 2 papers were in the first decile, 2 in Q1, 6 in Q2, 0 in Q3, 4 in Q4, and 1 output was a conference proceeding. Practical outputs including patents or licences are missing. As the engineering branch of the Institute, practical outputs are expected.	
H1.4	**The most valuable discoveries and findings in the fields, their importance for the field**
The achievements in large scale and networked systems theory seems to be the most valuable contributions of the Team. Three of the papers in the field are appreciated by the international scientific community with a total of 74 citations which is very satisfactory. The	

achievements in other research directions and the contributions to the engineering field have less impact.

H1.5	Contribution of the participation of the authors in large collaborations

Not relevant.

Main criterion: 2. Societal relevance (H2.1-H2.5)

H2.1	Societal relevance of outputs and results pursuant to CAS and institute mission

The outputs are in compliance with the Institute mission and the societal relevance is recognized. In order to strengthen the position of the Team as the engineering branch of the Institute, it will be essential to emphasize more applied research directions.

H2.2	System functionality for knowledge transfer into practise, its usefulness for society. The impact of the team´s activity on proper practice in society in the area of social sciences and humanities

Although there is a claim in the documentation about transfer of achieved discoveries and knowledge into practice, this is so far only taking place via publications. Enhanced knowledge transfer into practise should be addressed in future.

H2.3	Relation to practice

As mentioned in criterion H2.2, the relation to the practise of the Team has room for improvement. The Team itself reports difficulties in moving towards more applied research. Presently the research capacities of the Team seem not to allow expanding the activities towards practical outcomes.

H2.4	Participation in AV21 strategy

Not relevant.

H2.5	Cooperation with regions of the Czech Republic

The team has rather strong cooperation with CTU, Faculty of Mechanical Engineering and Faculty of Electrical Engineering. For the educational knowledge transfer towards education this can be considered as satisfactory. The relation of the team to Czech industrial partners (Skoda and others) could open the path to practical outcomes of the research in the future.

Further criterion: 1. Position in international and national context (D1.1-D1.3)

D1.1	Comparison of the team with similar international and national institutes

In the field of "Robotic Walking", the Team has developed innovative approaches and presents alternative ideas (e.g. constraints for synchronization), but is not yet competitive with other international groups in the field, e.g. the Cybernetics Institute in Nantes, France.

D1.2	Scope and quality of international and national cooperation and the role of the team in such cooperation; engagement in broad international cooperation

The cooperation with 2 national and 6 international universities and institutes is highly appreciated and the importance of the team members in these cooperation is shown by a

number of joined outputs. As already stated, the application of results in practise is so far not a priority of the Team. However, the cooperation with Intel Corporation leading to 4 joint papers demonstrates the potential of collaborations with national and international industrial partners.

D1.3	Participation of the workers in scientific community activities (organizing of conferences and workshops, invited lectures, awards)

Considering the size of the Team, the number of invited lectures and membership in Program Committees of international conferences is adequate. However, mainly the team leader and partially the vice-team leader are involved in these activities. At least 3 or 4 team members are expected to participate in these activities to enhance the visibility of the Team in the field.

Further criterion: 2. Vitality, sustainability and strategy (D2.1-D2.9)

D2.1	Direction in line with the perspective of the planned research directions

The 4 planned research directions are consistent with the strategy plan of the Institute. However, with the current human resources of the Team, realisation of the research goals may be a challenge.

D2.2	Assessment of the previous research objectives and their achievement

According to the documentation, the research objectives were stated quite generally and have been widely reached by all teams. The main achievement of the Team "Control Theory" reported by the Institute was the method to study lateral dynamics of 3D walking-like systems/robots. However, as stated in the criterion H1.4, achievements in large scale and networked systems theory seem to be the most valuable contributions of the Team.

D2.3	Assessment of implementation of recommendations from past evaluation

With the exception of funding of the Team through EU programs, the previous recommendations were largely implemented. However, with the present size of the Team, it will not be easy to participate in most of the EU programs which require substantial research capacity. Increasing the number of FTE from 6.3 to 7.3 represents an improvement but there remain concerns about covering the planed research topics with adequate human resources.

D2.4	Success in receiving grants

The number of national grants may be considered as satisfactory in comparison to the size of the Team, but funding also through international grants would be beneficial. An industrial partner in the national or international area may be helpful for submitting an EU proposal. Moreover, stronger cooperation with other teams of the Institute which are successful in acquiring EU grants could allow the team members to participate in joint EU funding programs (such as e.g. the ALMARVI joint project of the Signal processing and the Image processing team).

D2.5	Adequacy of instrumental equipment

The main instruments used by the Team presently are software environments but a software sustainability policy was not clearly explained during the discussion. Based on documentation and presentation, it seems that the Team operates the only engineering lab in the Institute, and that the instrumental equipment is not sufficient for producing practical application results. Improvement of the lab equipment, e.g. by cooperation with industrial or other engineering partners, may help in transfering scientific results to engineering applications.

D2.6	Effectiveness of management

It seems that the Team has successfully handled the 4 directions of research despite of the limited team size in the previous evaluation period, which may be an evidence of good team management.

D2.7	Assessment of professional structure, development strategy and the strategy of keeping best scientists, age structure, career and qualification growth

The Team consists of 4 young members, 3 group leaders and 1 senior expert, which represents a certain promise for the further development. The career and qualification of young scientists is ensured through a satisfactory number of experienced group members. Supervision of PhD students is essential for the long-term sustainability of the Team. In the 5 years since the last evaluation, the Team does not seem to have reached a critical mass for engineering research in the application of Control Theory, which might endanger its long-term sustainability. This issue has to be addressed at the institutional level and measures to strengthen the Team should be considered.

D2.8	Creating work-life balance conditions, assessment of approach towards possible gender issues

See D2.8 of Institute Evaluation. The team size is too small to consider the relevance of gender issues.

D2.9	Relation of the team with regard to the integration, development and sustainability of the research centre funded by the National Programme of Sustainability II.

Not relevant.

Further criterion: 3. Cooperation with universities and participation in education (D3.1-D3.6)

D3.1	Scope of cooperation with universities on national and international level

The team is involved in 5 international and 2 national productive collaborations, which can be rated as satisfactory when considering the team size. The Team is encouraged to use these connections for future research.

D3.2	Effectiveness of joint research centres

According to documentation, there are no joint research centres established yet.

D3.3	Success rate in supervision of PhD students

4 PhD theses have been supervised. Supervision of PhD students is essential for the long-term sustainability of the Team.

D3.4	Participation of PhD students in the outputs

Participation of the PhD students in all outputs is recognized and acknowledged. There are five outputs with PhD student contribution selected for evaluation. It seems that PhD student participation in high quality outputs has room for improvement, and this will raise their motivation and support their future career.

D3.5	Participation of the team in master or bachelor studies

The Team reports active contribution to master and bachelor courses, which is important for the recruitment of prospective PhD students.	
D3.6	**Assessment of cooperation intensity with universities in the form of teaching**
See D3.5.	

Further criterion: 4. Outreach activities (D4.1-D4.3)

D4.1	**Sufficiency of media strategy and activities in the area of research popularisation**
Few outreach activities are reported even for a small team. However, an interesting YouTube video of robotic walking aimed at science popularization for high school students and the general public is mentioned. It would be beneficial to increase public engagement activities to raise awareness for the research field and team activities among different target groups, for example high school students. These activities may help in the recruitment of students in a long-term strategy.	
D4.2	**Publishing activities and its quality**
See D4.1.	
D4.3	**Participation in professional organisations in the area of research and development**
The participation and membership in professional organizations such as editorial boards of journals and active membership in IEEE is documented. However, as already mentioned in criterion D1.3, these activities are mainly performed by the team leader and partially the vice-team leader. Broader involvement of more team members may be beneficial for the Team.	

Other comments of the commission:
The Team is excellent in very narrow fields but has not yet reached a critical mass. On the national and international level, Control Theory is usually associated with Electrical Engineering. It is therefore recommended that the Team strengthens its existing and initiates new cooperation with Electrical Engineering groups in other Academy Institutes as well as university institutes. The Team has thereby the potential to develop into the engineering branch of the Institute.
Concluding Remark: The Commission is aware of the fact that virtual site visits cannot replace meetings person-to-person. Nevertheless, based on the documentation provided and the virtual site visit the Commission has made every effort to arrive at an objective and comprehensive Evaluation of the Team.

3. Department of Decision Making Theory

Strengths:

The team has a healthy age distribution of researchers that assures continuity of the research field represented by its members. It has seen a growth of the number of full-time equivalents from 10.65 in 2015 to 15.68 in 2019. The team is mostly made of mathematicians that are interested in mathematical modeling involving differential equations, Bayesian networks, mathematical logic, among other subfields. Among many areas that the team identified as the centre of their research activities, there are three that are dominant in the research output as well as in their sizes: *a) Variational analysis and its applications, b) Mathematical methods in mechanics of solids, calculus of variations, computational mechanics, and numerical analysis, and c) Mathematical logic.* These three groups constitute the core of the team. Other subgroups (seven of them by the count from the report) also produced some valuable research published in internationally recognized journals. Among other sub-teams, a strong field emerges that deals with conditional independence structures and Bayesian networks. For a team that could fit well to an applied mathematics institute, it generates sufficiently diversified applied research to justify its location in the Institute of Information Theory and Automation. There is an evident growth in the number of the funded projects as compared to the previous evaluation period.

Weaknesses:

Some of the smaller teams continue to be weaker in the quality of their research and their current output does not project well on the future development of the areas of research those teams represent. In this sense, the team may be viewed as too fragmented in its research interests. This is amplified by an apparent lack of deeper interactions between the sub-teams. This may not be a problem for large sub-teams but it affects the smaller sub-teams. The funding is based mostly on the Grant Agency of the Czech Republic and also on various international joint projects, for example, through the collaboration with international counterparts.

Opportunities:

The two main teams can be viewed as working in the general field of variational analysis and thus stronger interactions and embarking on some joint topics should further strengthen the quality of the output. Combining the competence of the sub-teams in conditional independence structures and Bayesian networks should bring better recognition and strengthen the visibility of the group.

Threats:

The common problem for all the groups is the chronic lack of well-structured access to Ph.D. students. This is addressed in the overall discussion of the institute. It appears that a solution to the problem has to be solved on the level of the CAS or above. This relatively well-established team and with a positive rate of research growth had only 0.68 Ph.D. students in 2019 compared to 2.38 in 2015. This is very unhealthy and of high concern for sustainability in the future. To make things even more worrisome, according to the presentation all (four) current Ph.D. students are with a small subgroup in probabilistic models of decision support systems. Beyond this critical problem with access to Ph.D. students, it appears that some of the smaller subgroups may disappear shortly due to their size despite that the quality of the output is fairly good. Some other subgroups may need some support to hire a more distinguished researcher to lead them to improved research output quality.

Main criterion: 1. Quality of results (H1.1-H1.5)

H1.1	Quality of selected outputs of Phase I

The team achieved the following distribution of ratings

1	2	3	1 or 2
30,0%	53,3%	13,3%	83,3%

1 „*world leading*", 2 „*internationally excellent*", 3 „*recognized internationally*"

Thirty outputs have been selected and the quality of journals was high by the international standards. The quotation rate is not that impressive considering an applied slant of most of the publications.

H1.2	Contribution of workers on the outputs reached

A clear majority of the publications are driven by researchers from within the group.

H1.3	Quality of all outputs and results

The quality of the outputs is good. No evidence of any breakthrough results.

H1.4	The most valuable discoveries and findings in the fields, their importance for the field

While no breakthrough results can be identified in the diverse portfolio of the outputs, few of them should be mentioned as a solid contribution to the fields represented in the group. An important contribution in the most visible fields of expertise is the monograph: *Mathematical Methods in Continuum Mechanics of Solids* authored by two members of the team. In the same field, we have a SIAM Review paper from 2017 that provides a modern survey of methods for the calculus of variation. The articles in SIAM Journal on Optimization (2016) on Lipschitz condition for multifunctions, SIAM Journal on Mathematical Analysis (2018) on the characterization of Young measures, and IEEE Information Theory (2016) on entropy region and convolution stand out as important theoretical results. The comparison of other outputs is difficult due to the mentioned diversity fields.

H1.5	Contribution of the participation of the authors in large collaborations

Nearly all contributions are at a level of 33% or higher and large collaboration publications are very rare. Thus one concludes that the contribution to collaborative efforts is solid.

Main criterion: 2. Societal relevance (H2.1-H2.5)

H2.1	Societal relevance of outputs and results pursuant to CAS and institute mission

The group attempts to deliver directly on several societal relevant topics: material science, solid mechanics, portfolio theory, energy finance, health studies, economics, artificial intelligence, among others. However, the most significant contributions are to the theory that belongs more to the fundamental research rather than direct applications. Nevertheless, such contributions are also vital for scientific development in support of the direct applications and its societal relevance is high but needs the support of national research institutions such as CAS.

The output of the group is highly relevant to the mission of *the Institute of Information Theory and Automation (IITA)*. The diversity of the group and the quality of the research results in quite relevant applied research involving highly sophisticated mathematical

methods. Combining such a solid team of applied mathematicians to work within the IITA could only be realized within the structure of The Czech Academy of Science and thus standing well in-line with the main purpose of a national research institution.

H2.2	**System functionality for knowledge transfer into practice, its usefulness for society. The impact of the team´s activity on proper practice in society in the area of social sciences and humanities**

The direct transfer of the knowledge into practice is less evident from the activities of the group. With exception of a few and not that highly recognized contributions, the main research output is on a more fundamental level at which direct impact on society is not yet visible. The effect on social sciences is mostly through some research relevant to economics (if the latter can be counted as a part of social science) and studies of some machine learning models for language and internet data mining. The latter can have some impact on humanities but in a very general sense.

H2.3	**Relation to practice**

A large part of the team's research has significance for other sciences, engineering, and economics. Several publications demonstrated that through the various applications it has practical importance. However, it appears that the role of the group is rather to provide mathematical competence for solving advanced problems for which practical consequences are hard to evaluate at this level of generality. If the direct relation to practice is one of the priorities for CAS, the group needs to strengthen ties with the industry and bring more engineering expertise or collaborate with some industrial partner. At the moment, this type of activity is missing except for some pilot research using machine-learning/data mining.

H2.4	**Participation in AV21 strategy**

No active participation in the AV21 strategy has been explicitly mentioned by the group in its report and during the meetings. However, based on the research profile of the group the following two programs seem to be relevant to the research outcome of the group:

Programme 5. New Materials Based on Metals, Ceramics, and Composites

Programme 7. Wellbeing in Health and Disease

Programme 1. Hopes and Risks of the Digital Era

Perhaps, the connection to the AV21 strategy should be enhanced and made more visible in the presentation of both the group and the institute as a whole.

H2.5	**Cooperation with regions of the Czech Republic**

The activities are not highlighted in the documents or the presentations. A joint project Palacký University in Olomouc on *AI methods in Verb Class Analysis for Low-Resource Languages* has been reported. Surprisingly very little was found about using Ostrava's computing centre despite the evident focus on the computational aspect of most of the research fields.

Further criterion: 1. Position in international and national context (D1.1-D1.3)

D1.1	**Comparison of the team with similar international and national institutes**

	The team generates high-quality outputs and manages to get funds to carry out several scientific initiatives. Apart from the diversity of research fields and the almost null intersection among subgroups the team ranks among the best both nationally and internationally.
D1.2	**Scope and quality of international and national cooperation and the role of the team in such cooperation; engagement in broad international cooperation**
	Different subgroups or even researchers maintain their network of contacts with lots of outcomes. From publications to international committees and event organization activities. Some of the researchers have key roles in these initiatives.
D1.3	**Participation of the workers in scientific community activities (organizing of conferences and workshops, invited lectures, awards)**
	The team presents a long list of scientific activities in which they participate. Worth mentioning are some leading editorial roles in relevant journals. There are also about 12 conferences and workshops organized in the evaluated period. And also a long list of invited lectures at different kinds of scientific events. Worth mentioning is the award of the CAS 2018 received by J. Outrata.

Further criterion: 2. Vitality, sustainability and strategy (D2.1-D2.9)

D2.1	**Direction in line with the perspective of the planned research directions**
	The planned research directions follow the previous inertia of the team. In particular, they aim at maintaining the same level of relevant publications and participation in scientific activities in general.
D2.2	**Assessment of the previous research objectives and their achievement**
	Since the previous research objectives (as well as the new ones) are not particularly ambitious, one can say that they have been fully achieved.
D2.3	**Assessment of implementation of recommendations from past evaluation**
	Very little has been commented on this. Reflection was limited to comment on horizontal collaboration with other teams within other Institutes of CAS. No comment on concentrating on a few core areas to increase success and visibility.
D2.4	**Success in receiving grants**
	Several researchers have shown their ability to raise funds for research. But it looks that the total amount obtained is not enough to carry on attracting talent.
D2.5	**Adequacy of instrumental equipment**
	It looks that no specific equipment is required for the current activity in the group.
D2.6	**Effectiveness of management**
	None of the funded projects appears to need special management abilities.
D2.7	**Assessment of professional structure, development strategy and the strategy of keeping best scientists, age structure, career and qualification growth**

The group is large, with a very appropriate and balanced age spectrum. The team attracts a moderate number of Ph.D. students that actively participate in the team outputs. This moderate number has a decreasing tendency which could constitute a mid-term problem for the team.

D2.8	Creating work-life balance conditions, assessment of approach towards possible gender issues

Not documented.

D2.9	Relation of the team with regard to the integration, development and sustainability of the research centre funded by the National Programme of Sustainability II.

Not relevant.

Further criterion: 3. Cooperation with universities and participation in education (D3.1-D3.6)

D3.1	Scope of cooperation with universities on national and international level

Several researchers in the team participate and collaborate with national and international universities.

D3.2	Effectiveness of joint research centres

The team does not mention any joint research centre.

Some members of the team attend seminars organized by the Necas centre. The connections to the Necas centre should be strengthened. It appears to be a platform for identifying joint research interests across the mathematical groups in the different CAS institutes and in this way it also might help to constitute larger groups when it comes to applications for funding.

D3.3	Success rate in supervision of PhD students

There are no figures but it looks that the team manages to get a decent number of Ph.D. theses defended. These numbers go much higher when it comes to MSc and BSc theses. The number of Ph.D. students during the evaluated period (7) and the current ones (4) is rather poor given the size and level of the team.

D3.4	Participation of PhD students in the outputs

In the team Ph.D. students fully participate in research and manage to have their work published in very relevant journals and conference proceedings.

D3.5	Participation of the team in master or bachelor studies

The team is involved in teaching at all levels and specifically in master and bachelor levels.

D3.6	Assessment of cooperation intensity with universities in the form of teaching

Cooperation in teaching at several universities is high. Several researchers teach advanced subjects very related to their expertise which is very important to attract future collaborators.

Further criterion: 4. Outreach activities (D4.1-D4.3)

D4.1	Sufficiency of media strategy and activities in the area of research popularisation

This is one of the weakest aspects of the team. Very few outreach activities have been reported. Worth mentioning is the large term seminar „Mathematical problems of nonmathematicians".

D4.2	Publishing activities and its quality

Only one (local) publication of this kind has been reported. Its quality cannot be assessed.

D4.3	Participation in professional organisations in the area of research and development

Several subgroup leaders and other researchers are participating in important professional organizations with leading roles.

Comments and recommendations:

The group is strong in many aspects. Mainly at obtaining top-quality publications, carrying out international collaborations, and getting grants.

The main weakness is that the team is an almost disjoint union of several independent sub-teams. Some of the subgroups could benefit from joint, more ambitious initiatives.

The size and quality of the subgroups vary and some smaller groups having a good research potential could benefit from adding an accomplished researcher to boost the quality of their research output.

The numerically oriented members of the team should come into contact with the Applied Mathematics group from the Institute of Geonics. An exchange on numerical strategies could be beneficial for all. The group members working on various problems from continuum mechanics should intensify the exchange with members from the Evolution Differential Equation team at the Institute of Mathematics. This could for instance happen through joint activities within the Necas Center.

Other comments of the commission:

4. Department of Econometrics

Strengths:

The Team is small, young, with high energy and scholarly drive. The Team is pursuing world-class research in the fields of financial econometrics, energy economics, real and monetary macro-dynamics and stochastic and dynamic optimization.

Methodologically, their strengths are in the development of mathematical models and statistical procedures to better understand economic and financial phenomena with the main focus on statistical estimation using real-world data from economics and finance.

Weaknesses:

The small size of the Team can be viewed as a weakness. An excessive focus on just a few Team members as primary collaborators on all economics/econometrics journal submissions may be viewed as a weakness. A senior researcher with an international standing would have made a big difference for the Team.

From the funding perspective, the short-term nature of many research projects limits their ability to attract talent on a long-term full-time basis and to pursue a long-term research strategy.

Opportunities:

The team has been benefiting greatly from a closer cooperation with the economists in Prague which should be further encouraged while not losing sight of their proximity to mathematics, statistics and computer science within the Institute. The department's recent successes show that it has found the environment of the Institute to be conducive to their ambitions and this synergy is to be supported.

As during the previous evaluation, the Commission does not consider its task to promote any institutional changes to the structure of the Academy or the Institutes, but continued collaborations with CERGE-EI, a leading centre for economic research in Central and Eastern Europe, and further exploration of synergies with other UTIA departments might be beneficial for both institutes.

The team is taking advantage of the opportunities offered by short-term visits of leading scholars in the relevant areas. This is a great initiative and there is probably more that can be done in terms of connecting to leading centres and scholars.

Their placement within the Institute of Information Theory and Automation (UTIA) offers both challenges and opportunities. Econometrics being a subfield of economics is different from most exact sciences both in terms of research culture and in terms of hiring and retainment. Talent from related fields in applied mathematics call be productively involved in econometric projects while it may be difficult to attract people with PhDs in economics or finance from reputable universities as that market often offers plenty of lucrative alternatives.

Threats:

The structure of funding - about half of funds coming from short-term projects -- is both a weakness and a threat. This, on one hand, has resulted in a substantial increase in the available funds, mainly spent on the salaries; but, on the other hand, it brings an undesirable degree of instability and does not provide the researchers with a long-term certainty with respect to their employment contracts. The lack of sufficient institutional funding may impede the Institute Director and the Team Head's ability to properly support new projects in the initial stage, while they explore promising but not yet productive research directions.

The Team Head seems to play a critical role in the Team's activities including publications, external funding and joint projects. This leadership by example is commendable but can also be viewed as a threat particularly in this field where successful researchers are often hard to retain.

Main criterion: 1. Quality of results (H1.1-H1.5)

H1.1	Quality of selected outputs of Phase I

The team achieved the following distribution of ratings

1	2	3	1 or 2
20,0%	70,0%	5,0%	90,0%

1 „*world leading*", 2 „*internationally excellent*", 3 „*recognized internationally*"

The Team's selected outputs of Phase I include internationally reputable journals in the fields of financial econometrics and energy economics such as *Journal of Financial Econometrics, Econometric Reviews, Econometrics Journals,* and *Energy Economics*. These are not top field journals in econometrics such as *Journal of Econometrics* or top general interest journals such as *Econometrica* but some of these journals, e.g., *Journal of Financial Econometrics*, are very close to becoming top field journals.

In addition, there is a paper in *European Journal of Operational Research*, a top tier journal in operations research; there is a paper in *Journal of Economic Dynamics and Control*, a top tier journal in computational macroeconomics; and there are papers in *Journal of Financial Markets*, a top tier journal in finance.

The quality of selected outputs is outstanding to excellent.

H1.2	Contribution of workers on the outputs reached

Contribution of the Team members could be better balanced. Out of 19 outputs selected in Phase 1, 15 are authored or co-authored by the department director. Nonetheless, the description of the contribution suggests that the Team contributed to the paper idea even when the paper is co-authored by only two co-authored. This suggests that the Team takes part in the active generation of ideas for papers. This is an important contribution even if it is not recognized as co-authorship.

H1.3	Quality of all outputs and results

The list of all outputs is very extensive and includes a share of non-econometrics journals such as Fuzzy Sets and Systems and Physica A : Statistical Mechanics and its Applications. However, the papers deal with econometric topics and publishing in journals from related fields such as statistics, operations research, finance and applied math, is not uncommon in econometrics.

There are several papers in the local journal of the Institute Kybernetika. While the Institute Director informed that it does not have many local submissions, it is hard to assess the quality of output published in self-managed journals. Econometrics falls within economics where there is a well identified set of field journals and the department has been very successful in placing their papers there.

H1.4	The most valuable discoveries and findings in the fields, their importance for the field

It would take a lot of space to discuss the significant findings of the Team. There are many nice results. Primarily the Team's results sit in applied econometrics with emphasis on energy market and financial applications. But there are also a number of theoretical and methodological contributions, with some emphasis on frequency domain methods.

In the field of measurement of dependence between cyclical economic variables, the team introduced Quantile Coherency, a new general measure of dependence in time series, and developed estimators of this measure. This is a significant contribution that opens new directions in uncovering dependence structures in financial and economic data.

There is a new methodology developed for handling jumps in currency markets and evaluating their impact on correlations between exchange rates. The new methods use wavelet tools to better localize jumps which is a very practical and timely task in particular for the study of liquid currency markets.

Noteworthy is the research effort in the area of machine learning and statistical learning in economic application, where the Team explores the usefulness of such tools in the context of predicting crude oil prices and energy market volatility as well as in other data rich environments.

H1.5	Contribution of the participation of the authors in large collaborations

They had a number of successful collaborations over the reported period and they benefit from the current worldwide surge of interest in machine learning and AI in economics and finance and from the Institute's research links in these fields.

Main criterion: 2. Societal relevance (H2.1-H2.5)

H2.1	Societal relevance of outputs and results pursuant to CAS and institute mission

The Team's research output and results are of very high relevance to society in general and strongly promote the CAS and institute mission, specifically, through highly specialized research in econometrics, and through advancing scientific knowledge at the international level.

H2.2	System functionality for knowledge transfer into practise, its usefulness for society. The impact of the team´s activity on proper practice in society in the area of social sciences and humanities

The research is very practice oriented in that empirical applications form motivation for many of the Team's research projects. The results have practical focus. Examples include better management of markets for volatile assets, such as cryptocurrencies and better forecasting of energy prices.

H2.3	Relation to practice

This is an important aspect of research in particular during a pandemic. The Team raised to the occasion. There are critical practical applications such as City for people not for virus.

H2.4	Participation in AV21 strategy

No issues identified.

H2.5	Cooperation with regions of the Czech Republic

No issues Identified.

Further criterion: 1. Position in international and national context (D1.1-D1.3)

D1.1	Comparison of the team with similar international and national institutes

The Team is on a steep upward trajectory. Its research is already visible in terms of citations and the Team's position will definitely improve further in the next few years with the forthcoming publications in top economics and finance journals such as Review of Economics and Statistics and Review of Financial Studies.

There are no clear competitors that come to mind. They rank themselves regionally as number four after CERGE-EI, IES UK, and Czech National Bank. This looks reasonable.

D1.2	Scope and quality of international and national cooperation and the role of the team in such cooperation; engagement in broad international cooperation

The Team reports large scale international cooperation with a consortium of universities and an interuniversity centre in Europe. Nationally, they report collaboration with a number of Czech institutions.

D1.3	Participation of the workers in scientific community activities (organizing of conferences and workshops, invited lectures, awards)

They organize regular international conferences and workshops and invite luminaries to give talks. They participate in conferences actively. and they are members of scholarly societies and editorial boards. This activity is at a very high level.

Further criterion: 2. Vitality, sustainability and strategy (D2.1-D2.9)

D2.1	Direction in line with the perspective of the planned research directions

It seems the current research directions align well with the plan to further improve the Team's positions in the field of econometrics and machine learning. Further activities as outlined in the plan for the next five years appear appropriate.

D2.2	Assessment of the previous research objectives and their achievement

The plan was to improve the quality of publications and there are big successes in this. They also planned to expand their networks and they were able to do so by attracting a number of outstanding researchers to the Team for seminars, workshops and conferences.

D2.3	Assessment of implementation of recommendations from past evaluation

The recommendations from past evaluations have been implemented fully. For example, collaborations with researchers at Economics Institute offer great opportunities and have been exploited since the previous evaluation which recommended it. There are now joint papers and projects with econometricians from that group.

D2.4	Success in receiving grants

The Team reports joint grant projects with LSE, U Kiel, ZEW Mannheim, Humboldt U, U Castellon, and other unspecified partners in Ancona, Italy, and Vienna, Austria.

Specifically, the team reports 12 standard individual grants and 3 PostDocs. These successes are quite impressive.

D2.5	Adequacy of instrumental equipment

No issues identified	
D2.6	**Effectiveness of management**

The Team is seated within the UTIA institute and is thus bounded by the institute´s rules and management constraints. For example, when asked about criteria for career promotion, the UTIA director seems to have suggested that the decisions are rather ad hoc but there is a system of permanent contracts that successful researchers can enter.

It is hard to evaluate the effectiveness of the UTIA management from the information provided. The presentation of the director suggests that the UTIA offers to employees more than would be standard in the country and UTIA is a nice place to work in.

D2.7	**Assessment of professional structure, development strategy and the strategy of keeping best scientists, age structure, career and qualification growth**

Being the only social science department within an exact science institute must present its challenges. It is highly likely that relatively little decision making about retainment and recruitment can take place at the department level.

It is hoped that the specifics of hiring and retaining talent from the field of economics and econometrics is incorporated in the Institutes strategy.

The department leader looked quite convincing and proactive in describing the department strategy for balancing the age structure and for recruitment.

D2.8	**Creating work-life balance conditions, assessment of approach towards possible gender issues**

Work-life balance seems to be well provided for by the UTIA social infrastructure.

D2.9	**Relation of the team with regard to the integration, development and sustainability of the research centre funded by the National Programme of Sustainability II.**

No issues identified

Further criterion: 3. Cooperation with universities and participation in education (D3.1-D3.6)

D3.1	**Scope of cooperation with universities on national and international level**

The team reports close collaboration with major universities of the country done via regular lectures and specific large Master of Science courses in such fields as quantitative finance and applied econometrics. There are many theses at various levels of study that were advised by the team members during 2015-2019 and this research training is used to attract capable students to the team.

The scope of cooperation with Czech universities appears to be sufficiently wide.

D3.2	**Effectiveness of joint research centres**

There are several research centres with universities which involve the team. Judging by the amount of funding attracted by the centres these involvements have been quite effective.

D3.3	**Success rate in supervision of PhD students**

The Team reports 10 successful PhD thesis defences in 2015-2019 that is about two each year. This is a solid result for a research department that has no PhD program of its own.

D3.4	Participation of PhD students in the outputs

The 10 PhD students are reported to work jointly with supervisors on publication of research papers, but also encouraged to become independent scholars.

D3.5	Participation of the team in master or bachelor studies

The team reports having participated in 11 large Master of Science courses and having supervised 64 Bachelors and 120 Masters theses in 2015-2019 which is a notable achievement given the small size of the team.

D3.6	Assessment of cooperation intensity with universities in the form of teaching

11 large courses in 5 years is on average 2 a year, i.e. one course every semester. This level of teaching corporation is reasonable for a research focused department.

Further criterion: 4. Outreach activities (D4.1-D4.3)

D4.1	Sufficiency of media strategy and activities in the area of research popularisation

They have had several engagements with high schools and a television station.

D4.2	Publishing activities and its quality

No issues identified

D4.3	Participation in professional organisations in the area of research and development

They have a wide range of memberships in scholarly societies mentioned elsewhere

Other comments of the commission:

5. Department of Image Processing

Strengths:

For more than 10 years the Image Processing team has focused on 5 research topics: moment theory and invariants, image restoration, image forensics, cultural heritage and its applications, and medical imaging. Over the years the team developed deep expert knowledge in these areas. In the past period the team started a new research direction of deep learning and convolution neural networks. The combination of this direction with the existing areas promises huge potential for future research.

The team has a strong cooperation with renowned international universities and research institutes and has common publications with researchers of those institutes. Strong International contacts resulted also in participation of two International projects.

The team is also active in applications and solving problems for local industry.

The team invested time and effort in educational programs. Thanks to this educational effort the team attracted many young students and researchers.

Weaknesses:

Over the years Prof. Flusser played a leading role in the team, he started many new innovations and was awarded for that. A strong leader/researcher has definite enormous advantages for the team, but could be a future risk if no successors are early selected and prepared.

The team is involved in many industrial projects and applications. Consultancy is awarded and may result in new projects. But there is also a risk that these applications don't result in scientific outputs.

Opportunities:

In the past period the team started a new research direction of deep learning and convolution neural networks. This direction will fertilize the research in the team and also lead to good opportunities of collaboration and mutual fertilization with several other units of the CAS.

Image analysis has a high societal relevance and interest. This supports attraction of application and funding for new projects. These projects could provide interesting topics for Master thesis projects. If such student projects are well designed to fit into the existing research framework and supervision by PhD students, there will be high mutual benefit for the students and the team.

Threats:

Involvement in many international projects and applications has its benefits for the team, but it also takes a lot of time for acquisition and management.

Main criterion: 1. Quality of results (H1.1-H1.5)

H1.1	Quality of selected outputs of Phase I		
The team achieved the following distribution of ratings			
1	2	3	1 or 2
8,1%	40,5%	43,2%	48,6%

1 „*world leading*", 2 „*internationally excellent*", 3 „*recognized internationally*"

The team selected 37 outputs for the evaluation. Among them, 49% was classified into categories 1 and 2. These publications appeared in top area-relevant journals and high-impact conferences venues.

H1.2	Contribution of workers on the outputs reached

Most papers have at least three (co-)authors. This implies that the paper is not based on research of a single researcher but more team members are involved. Some researchers are dominant in the research, but it can be observed that many researchers of the team are visible in publications.

About 57% of the publications were co-authored with PhD students, stressing the impact and importance of PhD students.

H1.3	Quality of all outputs and results

Many papers are published in journals with a high impact factor, so the quality of publications is (very) good.

H1.4	The most valuable discoveries and findings in the fields, their importance for the field

The team was involved in theoretical and application-oriented research. The most visible contributions are the series of works on fundamentals, algorithms, and applications of the moment theory. Also the works on a number of image processing problems including deblurring and recently tracking are highly recognized.

H1.5	Contribution of the participation of the authors in large collaborations

Members of the team participated in two large international projects. This resulted in many common publications.

Main criterion: 2. Societal relevance (H2.1-H2.5)

H2.1	Societal relevance of outputs and results pursuant to CAS and institute mission

The close collaboration with industrial/commercial partners has a lot of potential in various fields. For example, research in radar interferometry will be used for assessment of bridge deformation. The team also invested in inspection of surfaces of roads for construction and repair.

H2.2	System functionality for knowledge transfer into practise, its usefulness for society. The impact of the team´s activity on proper practice in society in the area of social sciences and humanities

Research in the area of cultural heritage resulted in new image processing algorithms to be used in artwork analysis. Important developed image processing tools will be used as diagnostic tools in the medical area.

H2.3	Relation to practice

The team maintains intensive contacts and collaborations with institutions in real practice. With its strong expertises in various fields it can make considerable contributions to the development and broad use of advanced image processing systems.

H2.4	Participation in AV21 strategy

Recently the team got involved in satellite imaging in the framework of the Copernicus program. In a pilot project information was obtained on biomass information, the composition of crops and distribution of water bloom in stagnant water. The team also organized a workshop on Mathematics and Computer Science in Practice in the framework of AV21.

H2.5	Cooperation with regions of the Czech Republic

No information is provided in the report.

Further criterion: 1. Position in international and national context (D1.1-D1.3)

D1.1	Comparison of the team with similar international and national institutes

The team is competitive on the international level. Members of the team cooperate for example with outstanding institutes such as Cambridge and Florence. The image processing team was selected based on similarity in research abilities and output.

D1.2	Scope and quality of international and national cooperation and the role of the team in such cooperation; engagement in broad international cooperation

The team cooperates with researchers of top research institutes and also participates in two large international projects. These cooperations resulted in common publications in highly impacted journals.

D1.3	Participation of the workers in scientific community activities (organizing of conferences and workshops, invited lectures, awards)

Members of the team are active members of national and international scientific communities. Some are editors of international journals. The team regularly organises summer and winter schools on image processing. Prof. Flusser is awarded with the Felber Medal of the Czech Technical University and the Academic Premium award. Other members received many best paper awards. Members of the team were keynote speakers of three international conferences.

Further criterion: 2. Vitality, sustainability and strategy (D2.1-D2.9)

D2.1	Direction in line with the perspective of the planned research directions

In the period 2020-2024 the team will continue the research of the past period. They will invest more in deep learning methods using the existing knowledge of the team.

D2.2	Assessment of the previous research objectives and their achievement

The team promised to perform innovative research in 5 areas and to start research in the area of deep learning. This mission was accomplished successfully and many papers were published in highly impacted journals and highly ranked conferences. It is still not common use to define criteria in operational terms so that it is possible to measure progress in a quantitative and qualitative way.

D2.3	Assessment of implementation of recommendations from past evaluation

Members of the team didn't apply for an ERC grant. Two international projects and the award of Prof. Flusser took too much time and effort. With respect to the second

recommendation concerning recruitment of staff members and leaders in new areas, it can be noticed that four PhD students graduated successfully. They continued their work in the team and founded new small research groups.

D2.4	Success in receiving grants

In the current period the team got many PhD and research grants. The team also got support from two international projects. But the most prestigious award was the Praemium Academiae award for Prof. Flusser.

D2.5	Adequacy of instrumental equipment

The growth of research using deep learning and convolution neural networks based on big databases extracted from social media requires high performance computing and huge data storage facilities. They should be provided by other parties inside or outside the CAS.

D2.6	Effectiveness of management

The image processing team is one of the largest teams in the institute. The team is split up in 5 small work units around the defined research topics. A lot of discussions takes place in an informal way. To enable team meetings, the board ordered the construction of a big meeting room. The average age of the team is low. The board takes care that there is no discrimination between team members with respect to age. The board created an open atmosphere within the team.

D2.7	Assessment of professional structure, development strategy and the strategy of keeping best scientists, age structure, career and qualification growth

The average age of the team is low. Younger people are over represented. PhD students are stimulated to start their own research group after their PhD defence and stay within the team. The research topics of the team attract a lot of young scientists. The team is still growing, thanks to the presence of excellent researchers and starting research in societal relevant research around data mining and deep learning.

D2.8	Creating work-life balance conditions, assessment of approach towards possible gender issues

As stated above, the team attracts young researchers and many of them stay within the team for a long time. There are no statistics available for the percentage of female members of the team.

D2.9	Relation of the team with regard to the integration, development and sustainability of the research centre funded by the National Programme of Sustainability II.

Not relevant.

Further criterion: 3. Cooperation with universities and participation in education (D3.1-D3.6)

D3.1	Scope of cooperation with universities on national and international level

More than 30% of the research staff is composed of students. These students participate in cooperation projects with Charles University and Czech Technical University. The team and especially the research topics of the team attract also master students to perform their master thesis project within the framework of current research projects or risky innovative industrial projects.

D3.2	**Effectiveness of joint research centres**

The team cooperates with many international and national research centres. From the scientific output it can be concluded that these cooperations are fruitful and resulted in many common papers.

D3.3	**Success rate in supervision of PhD students**

Four PhD students finished their study successful in the chosen time frame. They are still involved in research activities. The image processing team is one of the biggest teams in the institute. It could be expected that the team has the capacity to attract and supervise an increasing number of PhD students. During the evaluation period 12 PhD students were involved in research activities of the team.

D3.4	**Participation of PhD students in the outputs**

PhD students are stimulated to publish their research results. The students are visible in many common papers. About 57% of the publications were co-authored by PhD students, which is a proof that PhD students play an important role in the research of the team.

D3.5	**Participation of the team in master or bachelor studies**

About 12 students were supervised during their master thesis work. Given the fact that many PhD students were successful master thesis students, it is important to invest time and supervision in teaching activities.

D3.6	**Assessment of cooperation intensity with universities in the form of teaching**

The team offers many semestrial lectures, seminars and courses. Most of the courses are on (advanced) image processing. Even the best researchers of the team are involved in teaching activities. The lecture activities enable the team to interest students for research activities in image processing.

Further criterion: 4. Outreach activities (D4.1-D4.3)

D4.1	**Sufficiency of media strategy and activities in the area of research popularisation**

Members of the team appear regularly on TV and radio channels. Prof. Flusser was the main speaker in a popular TV talk show.

The team deploys several activities for the education of the young generation. The team plays an active role in activities to interest high school students in science.

D4.2	**Publishing activities and its quality**

In 2016 a new text book on moment theory was published by Flusser et al.

D4.3	**Participation in professional organisations in the area of research and development**

Members of the team act as consultants and board members in many professional organisations.

Recommendations:

The involvement in many international projects and applications requires a huge amount of time and resources for acquisition and management. The team should consider appointing supporting staff for these tasks.

Privacy and security may be a serious issue in a number of image and video processing projects. For instance, deep neural networks will be used for cross domain image retrieval. Such research needs guarantees for privacy and security of respondents. A special committee is needed to approve research proposals to secure ethical aspects.

6. Department of Pattern Recognition

Strengths:

There is an excellent body of work in the study of material appearance and reflective properties of surfaces. The gonioreflectometer work is quite unique and there is some important work on illumination invariants and texture modelling. The applications of the work from the team is important and varied with an appropriate tradeoff with basic and fundamental research on some topics. The team also has a strong international profile, good collaborations and are involved in the international academic community.

Weaknesses:

The phase I evaluation reports no 1-grade papers and 6 2-grade papers over the period. This is less than would be expected for a group of this size over the period. Some research directions produce relatively poor outputs. The work reported is largely computer vision and not really aligned with the name of the team. This can affect the way the work and the team are perceived both within and outside the Institute. The overall organization of topics does not seem optimal.

Opportunities:

There is a potential opportunity to reorganize research to better match the interests of the teams. There is a good body of computer vision research in the Institute, but it is spread between teams and there may be better cooperation from bringing this research together.

Computer vision and AI are very dynamic areas which are rapidly expanding, and there is an opportunity to explore new directions which can both produce excellent research and attract industry funding.

Threats:

Most of the topics studied in the team are historically grounded and have been studied for many decades. Without new strong, widely acknowledged results, the research could be viewed externally as 'old fashioned' and not in keeping with modern trends in the area. This can make it more difficult to get funding and have research papers accepted.

It is clearly more difficult to attract top research talent to the team because of the financial conditions and the short-term nature of many grants is not helpful. There is a danger that the best researchers will not want to work in the team.

Main criterion: 1. Quality of results (H1.1-H1.5)

H1.1	Quality of selected outputs of Phase I		
The team achieved the following distribution of ratings			
1	2	3	1 or 2
0%	35,3%	52,9%	35,3%
1 „*world leading*", 2 „*internationally excellent*", 3 „*recognized internationally*"			
There are no grade-1 outputs in the selection and 6 grade-2 outputs. This is less than one would expect from this team. Nevertheless, the team manages to get visibility in several important international conferences.			

H1.2	**Contribution of workers on the outputs reached**

Participation in outputs is quite uneven. Several team members contribute only in small amounts. The number of authors is moderate with some one author papers. Overall contribution is then satisfactory.

H1.3	**Quality of all outputs and results**

In computer science, we do not consider the bibliometrics to be particularly useful in assessing paper quality, so we have focussed mainly on the selected outputs. The total number of outputs (73) is not particularly large for the size of the team and the period. The quality of outputs in general is not as good as outputs in phase I but participation in international key conferences is worth mentioning.

H1.4	**The most valuable discoveries and findings in the fields, their importance for the field**

The modelling of BRDFs, with particular application to their perception and comparison. The measurement of BRDFs. This research is important to be able to capture the properties of surface materials and understand how they will be visually perceived in a variety of settings. It has applications in many areas, including object recognition, computer vision in general, graphics and rendering.

H1.5	**Contribution of the participation of the authors in large collaborations**

Members of the team participated in the large European collaboration ERCIM-MUSCLE.

Main criterion: 2. Societal relevance (H2.1-H2.5)

H2.1	**Societal relevance of outputs and results pursuant to CAS and institute mission**

The outputs and results of the team have no direct societal impact but some of their lines of research may have some relevance. Specially contributions on visual appearance and characterization that may lead to further collaborations with large companies.

H2.2	**System functionality for knowledge transfer into practise, its usefulness for society. The impact of the team´s activity on proper practice in society in the area of social sciences and humanities**

The team does not have direct initiatives on knowledge transfer and even at the level of the institute this is not strongly organised. The team partially covers these issues in some outreach activities.

H2.3	**Relation to practice**

It seems that the team is looking for opportunities with regard to practical outcomes of their research.

H2.4	**Participation in AV21 strategy**

The institute leads one of the AV21 goals together with other institutes. The research of the team falls in general into this goal. Professor Haindl was supervising the whole AV21 strategy scheme in the Czech Academy of Science, including its aims, rules, and evaluation criteria. Some outputs as one co-authored book on Industry 4.0 are worth mentioning.

H2.5	**Cooperation with regions of the Czech Republic**

The team has a large set of cooperation across the Czech Republic that covers different aspects from teaching in universities to collaboration with local companies.

Further criterion: 1. Position in international and national context (D1.1-D1.3)

D1.1	Comparison of the team with similar international and national institutes
Some of the work in the team is internationally competitive, with the remainder being nationally competitive. The team leaders are internationally well known. Overall the work compares with the top national teams.	
D1.2	**Scope and quality of international and national cooperation and the role of the team in such cooperation; engagement in broad international cooperation**
There is some evidence of international cooperation. There is involvement in a large European initiative and some jointly authored papers with teams around the world. The cooperation with computer vision groups nationally and internationally could be more extensive and the researchers should continue to explore European grants.	
D1.3	**Participation of the workers in scientific community activities (organizing of conferences and workshops, invited lectures, awards)**
There are excellent contributions to the scientific community through conference organisation and program committees, journal editing and learned societies.	

Further criterion: 2. Vitality, sustainability and strategy (D2.1-D2.9)

D2.1	Direction in line with the perspective of the planned research directions
The team aims at deeping into their current research lines and open new collaborations to increase its visibility and the quality of their outputs.	
D2.2	**Assessment of the previous research objectives and their achievement**
Previous research objectives have been reasonably achieved according to teams' perception.	
D2.3	**Assessment of implementation of recommendations from past evaluation**
The team has succeeded in addressing nearly all of the recommendations. The exception is that they still could do more in improving the publication strategy.	
D2.4	**Success in receiving grants**
5 domestic grants and one international grant are reported. This is a moderate success over the period. The team should continue to pursue European projects, although we understand this is difficult.	
D2.5	**Adequacy of instrumental equipment**
The gonioreflectometer is a big strength of the group, other equipment seems fine.	
D2.6	**Effectiveness of management**
It is not clear.	

D2.7	**Assessment of professional structure, development strategy and the strategy of keeping best scientists, age structure, career and qualification growth**
The team has a sound HR policy for the researchers and the age profile is very healthy.	
D2.8	**Creating work-life balance conditions, assessment of approach towards possible gender issues**
Not documented.	
D2.9	**Relation of the team with regard to the integration, development and sustainability of the research centre funded by the National Programme of Sustainability II.**
Not relevant.	

Further criterion: 3. Cooperation with universities and participation in education (D3.1-D3.6)

D3.1	**Scope of cooperation with universities on national and international level**
There is some evidence of cooperation with individual researchers from other universities at the national and international level.	
D3.2	**Effectiveness of joint research centres**
The is one joint research centre ('Salome') with Prague University of Economics.	
D3.3	**Success rate in supervision of PhD students**
The team supervised seven successfully defended PhD Theses during the evaluated period as was mentioned in the original material.	
D3.4	**Participation of PhD students in the outputs**
PhD students are fully integrated into the research of the team and are involved in a number of papers as well as the success of research projects.	
D3.5	**Participation of the team in master or bachelor studies**
The team supervised some 10 MSc theses and 4 Bachelor thesis.	
D3.6	**Assessment of cooperation intensity with universities in the form of teaching**
A substantial amount of university teaching is reported, with most senior members of the team teaching one or two courses, with the teaching across all levels of study.	

Further criterion: 4. Outreach activities (D4.1-D4.3)

D4.1	**Sufficiency of media strategy and activities in the area of research popularisation**
A few outreach activities are reported, but they could be expanded. There is some good impact from the work on virtual reality and cultural heritage.	
D4.2	**Publishing activities and its quality**

There are a couple of published books and a number of pieces of technical software have been published.	
D4.3	**Participation in professional organisations in the area of research and development**
Prof. Haindl has some considerable involvement in professional organisations. Other teams´ members should consider expanding their involvement.	

Comments and recommendations:

The team should be encouraged to undertake some more ambitious steps towards excellence. To this end, more horizontal collaborations with other groups in the same or neighbouring institutes could be considered. Moreover, the team could try to get into the very state of the art by increasing its visibility in top conferences and journals.

Other comments of the commission:

7. Department of Signal Processing

Strengths:

The team has high competence in hardware design towards real-time signal / image processing applications. It has long-standing collaboration with one of the key players of the industry and other companies in the country. The team is well visible in its field on the European level and successful in the related EU funding.

Weaknesses:

The output of the team is mostly limited to demonstrators only. It seems that the potential of making them used in real practice is not fully explored yet, including commercialization options. There exist several units at the CAS with activities in signal / image processing. It lacks collaboration to achieve better synergy and mutual fertilization.

Opportunities:

The application-oriented work of this team can be well combined with the methodologic and algorithmic developments from other units of the CAS in the fields of signal / image processing towards integrated advanced real-time processing systems.

The rapid development of AI, including machine learning / deep learning, and related intelligent signal / video processing provides huge potential for dedicated hardware design with real-time performance.

Threats:

The strong dependency of the team on success of project funding within the EU ECSEL program has the danger of negatively influencing the stability of the team.

Main criterion: 1. Quality of results (H1.1-H1.5)

H1.1	Quality of selected outputs of Phase I

The team achieved the following distribution of ratings

1	2	3	1 or 2
8,3%	0%	52,9%	8,3%

1 „*world leading*", 2 „*internationally excellent*", 3 „*recognized internationally*"

The funded projects of the team expect demonstrators and related software packages as output. This fact resulted in the very negative publication statistics. Only one of the 12 selected publications was classified into the top two categories.

Due to the unique characteristic of this team, one may consider the developed hardware designs, demonstrators, and software packages as benchmark. In that case the related outputs do have high-quality and are internationally well recognized.

H1.2	Contribution of workers on the outputs reached

A substantial element of the team's output is hardware design and construction. This is of an excellent standard and is a real credit to the Institute. However, it is difficult to assign credit to this kind of work in the same way as a publication. Suffice to say that the hardware produced by the team appears to be its own unique work.

H1.3	Quality of all outputs and results

The team has been quite productive and successful in its specific focus, i.e., hardware and software development.

H1.4	The most valuable discoveries and findings in the fields, their importance for the field

The team has developed a series of hardware demonstrators and related software packages.

H1.5	Contribution of the participation of the authors in large collaborations

The team has been quite successful within the EU ECSEL funding program.

Main criterion: 2. Societal relevance (H2.1-H2.5)

H2.1	Societal relevance of outputs and results pursuant to CAS and institute mission

The application-oriented work of this team can be well combined with the methodologic and algorithmic developments from other units of the CAS in the fields of signal / image processing towards integrated advanced real-time processing systems. Such systems are highly relevant for the economical development of the country.

H2.2	System functionality for knowledge transfer into practise, its usefulness for society. The impact of the team´s activity on proper practice in society in the area of social sciences and humanities

The team has close collaboration with Skoda Auto and other companies. Its work thus has high potential for industrial development.

H2.3	Relation to practice

The focus of the team on signal processing is mainly of practical nature (e.g., hardware implementation of advanced signal / image processing algorithms for real-time applications). Thus, the outputs have high potential to be applied in practice.

H2.4	Participation in AV21 strategy

No information is provided about participation in AV21 strategy.

H2.5	Cooperation with regions of the Czech Republic

The close collaboration with Skoda Auto and other companies contributes to the regional development.

Further criterion: 1. Position in international and national context (D1.1-D1.3)

D1.1	Comparison of the team with similar international and national institutes

The team has made efforts to improve on internationally relevant publications, but still ranks low in comparison to other similar groups both at national and international levels. But in terms of hardware and software design this team is well comparable with similar groups in this field, both at national and international level.

D1.2	Scope and quality of international and national cooperation and the role of the team in such cooperation; engagement in broad international cooperation

The team has quite a large international and national cooperation all in the context of the funded projects it is involved in. These projects lead to long and fruitful collaborations specially with large companies about very applied research.

D1.3	Participation of the workers in scientific community activities (organizing of conferences and workshops, invited lectures, awards)

The team has participated in some scientific events and activities but very much in the context of funded project dissemination either in organized information days or at exhibitions in conferences. The participation in more relevant scientific events is very poor in comparison with other similar teams.

Further criterion: 2. Vitality, sustainability and strategy (D2.1-D2.9)

D2.1	Direction in line with the perspective of the planned research directions

The team plans to establish itself as a reference in the same specific context as in previous periods. The team seems capable to find application domains and funding to continue applying its expertise.

D2.2	Assessment of the previous research objectives and their achievement

Previous research objectives related to applied research and knowledge transfer have been and continue to be assessed.

D2.3	Assessment of implementation of recommendations from past evaluation

Past recommendations pointed in the direction of increasing basic research and relevant scientific publications. This aspect has been increased but just marginally.

D2.4	Success in receiving grants

The team is very capable of looking for funding from applied research projects. There is no information about trying other kinds of grants, e.g., for research stays or establishing research networks.

D2.5	Adequacy of instrumental equipment

The team seems well equipped for the kind of tasks involved in the corresponding research projects.

D2.6	Effectiveness of management

According to the success in getting into funded projects, the management is more than adequate. But the team as a whole looks relatively small to tackle such a large number of simultaneous projects.

D2.7	Assessment of professional structure, development strategy and the strategy of keeping best scientists, age structure, career and qualification growth

Considering projects and work done, the team looks small but is slowly growing. The context in the team and in the institute makes it difficult to retain the best junior researchers or to attract senior ones.

D2.8	Creating work-life balance conditions, assessment of approach towards possible gender issues
Covered by the Institute's policy, and nothing remarkable is added at the team level.	
D2.9	Relation of the team with regard to the integration, development and sustainability of the research centre funded by the National Programme of Sustainability II.
Not relevant.	

Further criterion: 3. Cooperation with universities and participation in education (D3.1-D3.6)

D3.1	Scope of cooperation with universities on national and international level
Some of the team members do collaborate with teaching at the Czech Tech Univ. especially at the Faculty of Transportation. Teaching spans all grades from bachelor to doctoral studies, but perhaps the particular subjects could be more related to the research being carried out by the team.	
D3.2	Effectiveness of joint research centres
According to the documents, the team is involved or has specific collaborations with several research centres. Specifically, an EU funded research centre in Brno is mentioned.	
D3.3	Success rate in supervision of PhD students
There are no specific figures about success rate but considering the team size and current number of students, 4 PhD theses defended in the period can be considered as quite successful.	
D3.4	Participation of PhD students in the outputs
Only one full time PhD student is mentioned in the documents.	
D3.5	Participation of the team in master or bachelor studies
The team supervised 3 bachelor theses and one master thesis. Moreover, some members do teaching both at bachelor and master level at the university.	
D3.6	Assessment of cooperation intensity with universities in the form of teaching
Only two team members collaborate in teaching. The overall amount of teaching seems adequate but other team members could also contribute in this aspect and ideally the subjects could be more related to team expertise.	

Further criterion: 4. Outreach activities (D4.1-D4.3)

D4.1	Sufficiency of media strategy and activities in the area of research popularisation
Outreach activities are restricted to events and fairs where the companies involved in the funded projects present demos and prototypes developed within the projects.	
D4.2	Publishing activities and its quality

There are no specific publications devoted to disseminate the expertise and capabilities of the team apart from exhibitions related to finished works.	
D4.3	**Participation in professional organisations in the area of research and development**
Nothing has been reported apart from membership to some professional panel related to H2020.	

Recommendations:

It would be a pity to lose a team that is capable of such a large number of collaborations and participation in large well-funded research projects. But the team should be encouraged to fill in the gap between the particular applications in which companies are interested and the current state of the art and the corresponding basic research.

At the same line, the team usually participates in projects as a mere partner and occasionally as work-package leader. The team should try to lead more and more initiatives and try to shape appropriately the work done in these funded initiatives

Other comments of the commission:

8. Department of Stochastic Informatics

Strengths:

The team is able to produce high-quality theoretical outputs. The team maintains lively international collaborations at the level of individuals that have been fundamental for the high-quality scientific output. The team members are quite active in teaching at Czech universities.

Weaknesses:

The team has a very unbalanced age structure, there are 7 people in age category 40-45, but in other categories 0, 1 or 2 people. The team is very small and has microscopic subgroups inside the team. The team is not attractive for young researchers, PhD and MSc students. The goals of the group are not focused, the next period goals include 12 topics for 8 FTE. The team is complaining too much about bad external influences.

Opportunities:

It is helpful to reconsider the research topics in order to better focus the goals and to attract more young researchers, and PhD and MSc students.

Threats:

There is a risk that if there will be no changes in the management of the team, people may continue to leave the team and the activities of the team may disappear within the next five years.

Main criterion: 1. Quality of results (H1.1-H1.5)

H1.1	Quality of selected outputs of Phase I

The team achieved the following distribution of ratings

1	2	3	1 or 2
31,6%	52,6%	15,8%	84,2%

1 „*world leading*", 2 „*internationally excellent*", 3 „*recognized internationally*"

The team selected 19 outputs for the evaluation. Among them, 84% was classified into categories 1 and 2. This indicates a very high publication quality.

H1.2	Contribution of workers on the outputs reached

Contribution of workers on the outputs are comparable with the other mathematical teams.

H1.3	Quality of all outputs and results

Comparison to averages of the field of mathematics:

Average ratings of the team are below average ratings of the field,

Productivity of teams in excellent outputs: for rated 1 – over the average of the field, but for rated 1+2 – below the average of the field.

H1.4	The most valuable discoveries and findings in the fields, their importance for the field

The team selected three results to point out: two of them are purely theoretical and related to stochastic PDEs, and theory of particle systems. Thirdly, new algorithms for tensor decompositions are worked out. All these results are important for the field.

H1.5	Contribution of the participation of the authors in large collaborations

There are no large collaborations in the sense of category "D".

Main criterion: 2. Societal relevance (H2.1-H2.5)

H2.1	Societal relevance of outputs and results pursuant to CAS and institute mission

One of the goals of the institute and the CAS is to conduct fundamental research and this coincides with the research goals of the team. Furthermore, each society needs research groups which are involved in fundamental research.

H2.2	System functionality for knowledge transfer into practise, its usefulness for society. The impact of the team´s activity on proper practice in society in the area of social sciences and humanities

The team declares to carry out fundamental research and therefore their interest in transferring knowledge into practise is modest.

H2.3	Relation to practice

Most of the results are theoretical, but some algorithms related results can be considered as practical outputs.

H2.4	Participation in AV21 strategy

No information is provided about participation in AV21 strategy.

H2.5	Cooperation with regions of the Czech Republic

No indication is provided in the report.

Further criterion: 1. Position in international and national context (D1.1-D1.3)

D1.1	Comparison of the team with similar international and national institutes

In terms of very top outputs the team is on a comparable level with similar international and national institutes.

Only very theoretical problems are studied in subgroups of probability theory and mathematical statistics. The subunit on statistical signal processing is very small and it lacks connection with other units of the CAS related to signal processing.

D1.2	Scope and quality of international and national cooperation and the role of the team in such cooperation; engagement in broad international cooperation

The team maintains research cooperation with many researchers from abroad. More than 40% of the publications have at least one co-author from abroad. In addition, the team also contributes to the teaching at two national universities.

D1.3	Participation of the workers in scientific community activities (organizing of conferences and workshops, invited lectures, awards)

The team has a moderate participation in organizing international events (3 international conferences and 1 so-called program that seems to be comparable with a summer school).

J.M. Swart received high recognition for giving an invited talk at the World Congress in Probability and Statistics, 2016, organized by the Fields Institute, Toronto.	

Further criterion: 2. Vitality, sustainability and strategy (D2.1-D2.9)

D2.1	Direction in line with the perspective of the planned research directions
The team will continue in those areas, where it is active recently. The report described a large number of individual topics for future research, lacking a more focused view of research directions with indication of their importance to the fields.	
D2.2	**Assessment of the previous research objectives and their achievement**
The team has been successful in publishing high-quality papers, many being based on international collaboration at the level of individuals.	
D2.3	**Assessment of implementation of recommendations from past evaluation**
The recommendation to increase the number of postdocs and PhD students could not be satisfactorily implemented. Obviously, there was no progress related to the other two recommendations (increasing institutional funding and strengthening probability and statistics as basic research in the CAS). These important aspects are claimed to be not influenceable by the team, not even by the institute, which is not further elaborated.	
D2.4	**Success in receiving grants**
The team has been quite successful in acquiring funding, in particular from Czech Science Foundation.	
D2.5	**Adequacy of instrumental equipment**
Not relevant.	
D2.6	**Effectiveness of management**
The management should play a more active role in strategic planning. One example is concerned with increasing outreach activities to increase the attractivity of the field to the society and students. This is particularly important to alleviate the current serious problems (low number of students in the field, difficulty in recruiting young statisticians).	
D2.7	**Assessment of professional structure, development strategy and the strategy of keeping best scientists, age structure, career and qualification growth**
The team follows a long-term strategy to compete by offering non-financial advantages such as a low administrative load or large academic freedom. It is also the intention to have a "decentralized" organisation strategy. That is, instead of large groups working on a hot topic around an internationally renowned scholar, it is preferred to have a more heterogeneous collection of internationally well connected and highly productive researchers over a long period. The lack of Ph.D. students is a serious problem, for which no particular strategy (and even efforts, see D4.1) is noticeable.	
D2.8	**Creating work-life balance conditions, assessment of approach towards possible gender issues**
This is covered by the Institute's policy, and nothing remarkable is added at the team level.	
D2.9	**Relation of the team with regard to the integration, development and sustainability of the research centre funded by the National Programme of Sustainability II.**

Not relevant.

Further criterion: 3. Cooperation with universities and participation in education (D3.1-D3.6)

D3.1	Scope of cooperation with universities on national and international level
The team contributes to the teaching at the Charles University and the Technical University Liberec.	
D3.2	**Effectiveness of joint research centres**
No participation in joint research centres.	
D3.3	**Success rate in supervision of PhD students**
Only one PhD student defended his thesis in the evaluation period. This number is very low, in particular in relation to the number of (potential) supervisors.	
D3.4	**Participation of PhD students in the outputs**
The PhD students contributed moderately with a journal paper (of reasonable standing) and a small number of conference papers.	
D3.5	**Participation of the team in master or bachelor studies**
The team reported 15 bachelor courses (given by a single team member, Petr Volf) at the Technical University Liberec and a rather high number of master courses at two universities.	
D3.6	**Assessment of cooperation intensity with universities in the form of teaching**
The participation seems quantitatively reasonable. However, it is very unbalanced on the bachelor level.	

Further criterion: 4. Outreach activities (D4.1-D4.3)

D4.1	Sufficiency of media strategy and activities in the area of research popularisation
The team is rather passive in this aspect. It is unclear to which extent the members are encouraged to develop outreach activities and how they are supported to do so. The only activity is the participation of one member in introducing alternative methods of teaching mathematics and physics in several basic schools. The current situation is generally very unfavourable (low number of students in the field, difficulty in recruiting young statisticians). The passivity in such a situation is not helpful.	
D4.2	**Publishing activities and its quality**
None.	
D4.3	**Participation in professional organisations in the area of research and development**
Nothing has been reported.	

Comments and recommendations:
The team is able to produce high quality theoretical outputs, therefore it is a good idea to keep the support of the team at the current level: a group of good theoreticians is a value in itself.
On the other hand, if one likes to increase the vitality and sustainability of the team and to attract young researchers and students, one has to orient the focus of research to more practical topics. However, this needs serious changes in the management.

Other comments of the commission:
In all research fields of this team (probability theory and mathematical statistics, statistical signal processing) there exist units at the CAS with similar research interest. The collaboration between these units should be intensified. Potential structural changes are worth being taken into account in order to achieve better synergy and make the best out of the available expertises.

Final report was elaborated by:

Commission 1 - Mathematics and computer sciences
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      Xiaoyi Jiang
      Willi Jäger
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      Ulrich Ruede
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Commission 9 - Social sciences
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