Report on Deliverable D10.1

Strategic Analysis of the Supported Topics 2018

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Publishable abstract		The report presents the analysis of the outcome of the funded projects in the Call 2013 topics: • Adaptive Machines in Complex Environments • Heterogeneous Distributed Computing It also gives insight into the evolution of those topics.		
Keywords		Strategic analysis, supported topics, Call 2013		

Content Table

1. Overview of CHIST-ERA III Task Related to D10.1

The task related to the deliverable 10.1 covers the strategic analysis for the topics funded by CHIST-ERA calls. This task entails an analysis of the results obtained by on-going projects and aims at the definition of suitable criteria for the identification of emerging research communities and their maturity. In addition, an analysis of the needs and opportunities of research projects for specifically identified topics is conducted in order to determine their compatibility with possible future ICT programmes. Deliverables of this task, D10.1 and following, will be made available to the FET community and other fora.

2. Analysis and recommendation for the process

a. Scope of the Deliverable 10.1

In order to allow for maturation of both funded projects and topic, the deliverable 10.1 focuses on the topics of the Call 2013:

- Adaptive Machines in Complex Environments
- Heterogeneous Distributed Computing

Indeed the projects of the Call 2013 finished in 2018. During their lifetime, the corresponding research communities could form, exchange and present their vision of the future of their topics thanks to 4 editions of the CHIST-ERA yearly projects seminar.
This deliverable draws on the work performed in the task 9.1 Project follow-up and monitoring (for projects from all calls except Call 2017) and in the task 10.1 Project Seminar organisation.

b. Analysis of the Topic Adaptive Machines in Complex Environments (AMCE)

i. Evolution of the Funded Projects

Three projects were funded in the AMCE topic and the specific scope of each project is detailed in the table below:

Name	Project goals
AdaLab	Development of a framework for semi-automated and automated knowledge discovery (related to biological experiments) for teams of human and robot scientists, that integrates and advances knowledge representation, machine learning, bioinformatics, robotics and automated experimentation in given field
ALOOF	Enable robots to tap into the ever-growing amount of knowledge available on the Web, by learning from there about the meaning of previously unseen objects, expressed in a form that makes them applicable when acting in situated environments
COACHES	Address fundamental issues related to the design of a robust system of self-directed autonomous robots with high-level skills of environment modelling and scene understanding, distributed autonomous decision-making, short-term interacting with humans and robust and safe navigation in overcrowding spaces

There are 4 points on which those projects overlap:

1. Knowledge representation
2. Probabilistic reasoning about an uncertain environment
3. Human computer interactions
4. Planning – partial information, constraints

From the progress reports by the participating teams and the review reports by the scientific experts appointed by CHIST-ERA, we can conclude that in general the projects progressed according to the initial plan and generated relevant results, as detailed in the table below:

Name	Project major outcomes
AdaLab	• Integrated Autonomous System for Scientific Research • Three novel machine learning systems for generating scientific hypotheses • Two novel AI systems for deciding on scientific experiments • Novel biological knowledge about cancer and ageing
ALOOF	• Automatic creation of a perceptual and semantic knowledge base for robots on demand, from the Web • Large-scale, long term autonomous semantic mapping of space
COACHES	• Knowledge-based environment modeling • Distributed decision making and reasoning techniques for joint and collaborative activities • Multi-modal human-robot interaction • Face detection and body tracking • Physical implementations in real and different environments

ii. Evolution of the Topic

As part of the projects seminar's format, the projects in the same topic were invited each year to reflect on their progress and on the key challenges that still need to be tackled in their specific field. They produced presentations that are made public and available from the CHIST-ERA website (http://www.chistera.eu/funded-topics). The following challenges were identified in 2018:

- Planning – partial information, constraints
  - ✓ Representation of default knowledge and common sense knowledge
  - ✓ Unplanned and conflicting situation
  - ✓ Collaborative, multi-agent planning with partial information
- Human-robot knowledge building and sharing
  - ✓ Collaborative knowledge discovery
  - ✓ Fusion of heterogeneous sources of information
  - ✓ Adjustable and adaptive autonomy (under certified limits)
- Understanding and interpretation of information
  - ✓ Scene understanding: Relate object to environment and people behavior
  - ✓ Interpretation of models, making sense of data
  - ✓ Object functions, object-to-object relations, object-parts-relations, articulated and deformable objects

c. Analysis of the Topic Heterogeneous Distributed computing (HDC)

i. Evolution of the Funded Projects

Three projects were funded in the HDC topic and the specific scope of each project is detailed in the table below:

Name	Project goals
DIVIDEND	Attack the data center energy efficiency bottleneck through vertical integration, specialization, and cross-layer optimization. The vision of this project is to present

	heterogeneous data centers, combining CPUs, GPUs, and task-specific accelerators, as a unified entity to the application developer and let the runtime optimize the utilization of the system resources during task execution
DIONASYS	Raise the level of abstraction provided to designers of overlays and systems-of-systems. The aim of that project is reached via the use of a high-level domain-specific language, declaring what should be achieved for the structure and functions of overlays, rather than by defining low-level nodes interactions
HPDCJ	Ease of use and programmability of Java for distributed heterogeneous computing in order to make it exploitable by the huge user base of mainstream computing. This project introduced and transparently exposed parallelism in Java, with minimal change to the specifics of the language thus allowing programmers to focus on the application

There are 6 points on which those projects overlap, as detailed in the table below:

- Development of a programming model
- Improvement in data management
- Improvement in distributed techniques

From the progress reports by the participating teams and the review reports by the scientific experts appointed by CHIST-ERA, we can conclude that projects progressed generally according to the initial plan and generated relevant results, as detailed in the table below:

Name	Project major outcomes
DIVIDEND	• Vertical integration • Programming model • Energy accounting • Auto tuning • More heterogeneity • Fast networks
DIONASYS	• Generative programming • Application in IoT • System Composition
HPDCJ	• Parallel distributed computing in Java • PCJ library for parallel computing in Java • Scalability up to 6000 cores • CPU and GPGPU • Fault Tolerance • Easy for non-expert programmers

ii. Evolution of the topic

As part of the projects seminar's format, the projects in the same topic were invited each year to reflect on their progress and on the key challenges that still need to be tackled in their specific field. They produced presentations that are made public and available from the CHIST-ERA website (http://www.chistera.eu/funded-topics). The following challenges were identified in 2018:

- Upcoming challenges and needs
  - ✓ HDC call very much on-topic
    - Heterogeneity issues highlighted in the call getting increasing attention in science and technology communities
  - ✓ Distributed systems are (and will continue to get) more and more complex

        - Need programming models for the ordinary engineer
        - Software engineering research to the rescue?
            - Link with DevOps, microservices, etc.
            - How are startups doing?
    - ✓ HPC & Big Data convergence
        - HPC models for multiprocessors not amenable to heterogeneous computing platforms and accelerators
            - Clear need in Machine Learning!
- Specific needs in 5 years timescale
    - ✓ Programming models for major domains
    - ✓ DSLs to specialize to all devices (CPU, GPGPU, FPGA)
    - ✓ Eliminate waste in computing
    - ✓ SDN needs to be transparent the application
- Specific needs in 10 years timescale
    - ✓ Universal languages for the masses
    - ✓ Tool chains to co-design platforms and fabricate logic/network/memory blocks for services
    - ✓ Programming without knowing what's out there

3. General comments

Based on the scope of the supported topics and the progress and analysis of the funded projects about what still needs to be investigated, certain future calls from the ICT Work Programme 2018-2020 are identified as being of interest to the CHIST-ERA Call 2013 research communities.

Topic	Relevant ICT WP 2018-2019 Calls
AMCE	• **ICT-09 – Robotics in Application Areas** Specific Challenge: While robots originated in large-scale mass manufacturing, they are now spreading to more and more application areas. In these new settings, robots are often faced with new technical and non-technical challenges. The purpose of this topic is to address such issues in a modular and open way, and reduce the barriers that prevent a more widespread adoption of robots. Four Priority Areas (PAs) are targeted: healthcare, inspection and maintenance of infrastructure, agri-food, and agile production. User needs, ethical, legal, societal and economic aspects should be addressed in order to raise awareness and take-up by citizens and businesses. Privacy and cybersecurity issues, including security by design and data integrity should also be addressed, where appropriate • **ICT-10 – Robotics Core Technology** Specific Challenge: Autonomy in robotic systems is built on a combination of four core technologies: ✓ AI and Cognition: AI provides tools to make systems cognitive. Cognition equips robots with the ability to interact with people and environments, to learn and to categorise, to make decisions and to derive knowledge ✓ Cognitive Mechatronics: Mechatronic systems where sensing and actuation are closely coupled with cognitive systems are expected to deliver improved control, motion, interaction, adaptation and learning, and safer systems

	✓ Socially cooperative human-robot interaction: Cooperative human-robot interaction is critical in many work environments from collaborative support, e.g. passing tools to a worker, to the design of exo-skeletons able to provide motion that is sympathetic to the user ✓ Model-based design and configuration tools: Deploying robotics at scale in application areas where tasks need to be defined by the user requires easy-to-use configuration tools. Embedding and sharing of knowledge between tools is essential, as is standardisation across the interfaces to connect systems and modules (taking into account cybersecurity issues, including security by design and data integrity)
HDC	• **ICT-01 – Computing technologies and engineering methods for cyber-physical systems of systems** Specific Challenge: Cyber-physical Systems of Systems (CPSoS), like transport networks or large manufacturing facilities, interact with and are controlled by a considerable number of distributed and networked computing elements and human users. These complex and physically-entangled systems of systems are of crucial importance for the quality of life of the citizens and for the European economy. At system level the challenge is to bring a step change to the engineering techniques supporting the design-operation continuum of dynamic CPSoS and to exploit emerging technologies such as augmented reality and artificial intelligence. At computing level the challenge is to develop radically new solutions overcoming the intrinsic limitations of today's computing system architectures and software design practices • **ICT-15 – Cloud Computing** Specific Challenge: Develop competitive cloud solutions based on advanced cloud platforms and services and cloud-based software and data applications, as well as the opportunities brought by considering the edge devices capacities. Such solutions should also address stringent security, data protection, performance, resilience and energy-efficiency requirements to respond to the future digitisation needs of industry and the public sector. Addressing these challenges will also be part of and contribute to the technological ambitions for the Next Generation Internet (NGI) and the Internet of Things (IoT)