Proposal Book [- AMCE - All]

Proposal Data

Acronym	AdaLab
Full name	Adaptive Automated Scientific Laboratory
Duration	36
Topic	AMCE
Keywords	knowledge representation; machine learning; automated experimentation; ontology; artificial intelligence

Coordinator contact point for the proposal

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Consortium Partners

C/P	Institution	Contact	Other	Country	Legal Status	
C	Brunel University, Department of Information Systems and Computing	Dr Larisa Soldatova		United Kingdom	Public research organisation	**Ind.Eff.:**61 **Ind.Cost:**545,528 **Ind.Bud.:**436,422
P	University of Manchester, Manchester Institute of Biotechnology	Professor Ross D. King	Dr Victoria Jackson	United Kingdom	Public research organisation	**Ind.Eff.:**40 **Ind.Cost:**464,981 **Ind.Bud.:**371,985
P	University Paris-Nord LIPN	Professor Celine Rouveirol	Dr Henry Soldano, Dr Guillaume Santini	France	Public research organisation	**Ind.Eff.:**36 **Ind.Cost:**202,800 **Ind.Bud.:**202,800
P	University of Evry-Val-d-Essonne, iSSB	Dr Mohamed Elati	Dr Cuong T Chieu	France	Public research organisation	**Ind.Eff.:**36 **Ind.Cost:**186,160 **Ind.Bud.:**186,160
P	KU Leuven, Department of Computer Science	Dr Jan Ramon		Belgium	Public research organisation	**Ind.Eff.:**36 **Ind.Cost:**200,000 **Ind.Bud.:**200,000

Abstract:

Our proposal integrates the scientific method with 21st century automation technology, with the goal of making scientific discovery more efficient (cheaper, faster, better). A Robot Scientist is a physically implemented laboratory automation system that exploits techniques from the field of artificial intelligence to execute cycles of scientific experimentation. Our vision is that within 10 years many scientific discoveries will be made by teams of human and

robot scientists, and that such collaborations between human and robot scientists will produce scientific knowledge more efficiently than either could alone. In this way the productivity of science will be increased, leading to societal benefits: better food security, better medicines, etc. The Physics Nobel Laureate Frank Wilczek has predicted that the best scientist in one hundred years time will be a machine. The proposed project aims to take that prediction several steps closer. We will develop the AdaLab (an Adaptive Automated Scientific Laboratory) framework for semi-automated and automated knowledge discovery by teams of human and robot scientists. This framework will integrate and advance a number of ICT methodologies: knowledge representation, ontology engineering, semantic technologies, machine learning, bioinformatics, and automated experimentation (robot scientists). We will evaluate the AdaLab framework on an important real-world application in cell biology with biomedical relevance to cancer and ageing. The core of AdaLab will be generic. The expected project outputs include: - An AdaLab demonstrated to be greater than 20% more efficient at discovering scientific knowledge (within a limited scientific domain) than human scientists alone. - A novel ontology for modelling uncertain knowledge that supports all aspects of the proposed AdaLab framework. - The first ever communication mechanism between human and robot scientists that standardises modes of communication, information exchange protocols, and the content of typical messages. - New machine learning methods for the generation and efficient testing of complex scientific hypotheses that are twice as efficient at selecting experiments as the best current methods. - A significant advance in the state-of-the-art in automating scientific discovery that demonstrates its scalability to problems an order of magnitude more complex than currently possible. - Novel biomedical knowledge about cell biology relevant to cancer and ageing. - A strengthened interdisciplinary research community that crosses the boundaries between multiple ICT disciplines, laboratory automation, and biology.

Relevance:

The proposed AdaLab will be an autonomous system perceptive to human requirements (its scientific collaborators), with the ability to continuously learn, adapt and improve in the real world complex environment of scientific research (specifically yeast microbiology experiments related to cancer and ageing). The AdaLab will be capable of continuous cycles of scientific hypothesis formation and experimentation that will improve its scientific knowledge (models). We will take a systems approach, with the research involving collaboration between experts in: robotics, machine learning, logical and probabilistic inference, semantic technologies, and yeast microbiology. Developing the AdaLab will involve the system integration of high-level reasoning about scientific knowledge with the control of low-level robotic movements to execute experiments. We will also develop a protocol for communication between human and robot scientists. Scientific knowledge is inherently uncertain. Therefore within the AdaLab framework we will develop Bayesian based methods that make inferences and plan experiments under uncertainty. Scientific knowledge is best represented using logic. To integrate logic with probabilities we will use statistical relational learning, and develop an ontology for representing uncertain knowledge. The success of the AdaLab framework will be objectively determined by quantitative measurements of the different system components, and the scientific knowledge generated.

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Proposal Data

Acronym	ALOOF
Full name	Autonomous Learning of the Meaning of Objects
Duration	36
Topic	AMCE
Keywords	Adaptive systems, open-ended learning, web mining, situated vision, real-world environments

Coordinator contact point for the proposal

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C	University of Rome La Sapienza, Dept. of Computer, Control and Management Engineering “Antonio Ruberti”	Prof. Barbara Caputo		Italy	Public research organisation	**Ind.Eff.:**12 **Ind.Cost:**357,568 **Ind.Bud.:**250,298
P	School of Computer Science, University of Birmingham	Dr. Nick Hawes	Dr. Lars Kunze	United Kingdom	Public research organisation	**Ind.Eff.:**6 **Ind.Cost:**581,234 **Ind.Bud.:**464,988
P	Technische Universität Wien	Prof. Markus Vincze	Aitor Aldoma, MS	Austria	Public research organisation	**Ind.Eff.:**10 **Ind.Cost:**309,910 **Ind.Bud.:**309,910
P	INRIA Sophia Antipolis, Wimmics team	Dr. Fabien Gandon	Dr. Elena Cabrio	France	Public research organisation	**Ind.Eff.:**6 **Ind.Cost:**743,346 **Ind.Bud.:**234,909

Abstract:

The goal of ALOOF is to 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. By searching the Web, robots will be able to learn about new objects, their specific properties, where they might be stored and so forth. To achieve this, robots need a mechanism for translating between the representations used in their real-world experience and those on the Web.

We propose a meta-modal representation, composed of meta-modal entities and relations between them. A single entity is composed of modal features extracted from sensors or the Web. Amodal completion supports perception in the absence of a complete set of features. The combined features link to the semantic properties associated to each entity. All entities are organized into a structured ontology, supporting formal reasoning. This is complemented with methods for detecting gaps in the knowledge of the robot, for planning where to effectively obtain the knowledge, and for extracting relevant knowledge from Web resources. By situating meta-modal representations into the perception and action capabilities of robots, we will achieve a powerful mix of Web-supported and physical-interaction-based open-ended learning. Our scenario consists of a home setting where robots have to find/retrieve objects while understanding their meaning and relevance in the assigned task. Our measure of progress will be how many gaps, i.e. incomplete information about objects, can be resolved autonomously given specific prior knowledge. We will integrate results on different mobile robot platforms ranging from smaller mobile platforms, over Metralabs Scitos to a home service robot HOBBIT.

Relevance:

ALOOF will develop a novel meta-modal representation supporting perception of objects, of their meaning and the ability to reason about them by robot systems, coupled with technologies to extract the knowledge populating such representation from Web resources. This will result in an understanding of every object encountered by robots in domestic settings: its name, class properties, appearance and shape, locations where to store, and associated functionalities. This will allow robots to store away objects using navigation and compliant actuation where necessary in real-life situations, considerably advancing their ability to deal with uncertainty, and of learning from errors and incomplete sensor data. Grounding Web-based knowledge into the robot semantic object map supports autonomy through the unsupervised acquisition of object knowledge when needed. This provides adaptability to novel situations. Obtaining missing knowledge from the Web will make robots able to operate autonomously in the real world. Object perception will create scene and context understanding and planning capabilities that will allow the robot to react and adapt to changes by learning continuously and appropriately. Augmenting robot capabilities and skills with Web-derived object knowledge will achieve a breakthrough in the introduction of robotics technology in diverse physical environments provided by the partners.

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Proposal Data

Acronym	COACHES
Full name	Cooperative Autonomous Robots in Complex and Humans Environments
Duration	36
Topic	AMCE
Keywords	Multiple service robots, environment modeling, decentralized decision-making, human-robot interaction, adaptation

Coordinator contact point for the proposal

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Consortium Partners

C/P	Institution	Contact	Other	Country	Legal Status	
C	University of Caen Basse-Normandie (UNICAEN)	Abdel-Illah Mouaddib	Frederic Jurie, Maroua Bouzid, Laurent Jeanpierre	France	Public research organisation	**Ind.Eff.:**120 **Ind.Cost:**658,269 **Ind.Bud.:**287,106
P	Sapienza University of Rome	Luca Iocci	Daniele Nardi, Domenico Daniele Bloisi	Italy	Public research organisation	**Ind.Eff.:**75 **Ind.Cost:**343,750 **Ind.Bud.:**246,025
P	Vrije Universiteit Brussel	Hichem Sahli	Kris Steenhaut	Belgium	Public research organisation	**Ind.Eff.:**48 **Ind.Cost:**258,000 **Ind.Bud.:**200,000
P	Sabanci Universitesi, MDBF	Esra Erdem	Volkan Patoglu	Turkey	Private research organisation	**Ind.Eff.:**51 **Ind.Cost:**120,000 **Ind.Bud.:**120,000

Abstract:

Public spaces in large cities are increasingly becoming complex and unwelcoming environments. Public spaces progressively become more hostile and unpleasant to use because of the overcrowding and complex information in signboards. It is in the interest of cities to make their public spaces easier to use, friendlier to visitors and safer to increasing elderly population and to citizens with disabilities. Meanwhile, we observe, in the last decade a tremendous progress in the development of robots in dynamic, complex and uncertain environments. The new challenge for the near future is to deploy a network of robots in public spaces to accomplish services that can help humans. Inspired by the aforementioned challenges, COACHES project addresses 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. To this end, COACHES will provide an integrated solution to new challenges on: (1) a knowledge-based representation of the environment, (2) human activities and needs estimation using Markov and Bayesian techniques, (3) distributed decision-making under uncertainty to collectively plan activities of assistance, guidance and delivery tasks using Decentralized Partially Observable Markov Decision Processes with efficient algorithms to improve their scalability and (4) a multi-modal and short-term human-robot interaction to exchange information and requests. COACHES project will provide a modular architecture to be integrated in real robots. We deploy COACHES at Caen city in a mall called “Rive de l’orne”. COACHES is a cooperative system consisting of ?xed cameras and the mobile robots. The ?xed cameras can do object detection, tracking and abnormal events detection (objects or behaviour). The robots combine these information with the ones perceived via their own sensor, to provide information through its multi-modal interface, guide people to their destinations, show tramway stations and transport goods for elderly people, etc.... The COACHES robots will use different modalities (speech and displayed information) to interact with the mall visitors, shopkeepers and mall managers. The project has enlisted an important an end-user (Caen la mer) providing the scenarios where the CAOCHES robots and systems will be deployed, and gather together universities with complementary competences from cognitive systems (SU), robust image/video processing (VUB, UNICAEN), and semantic scene analysis and understanding (VUB), Collective decision-making using decentralized partially observable Markov Decision Processes and multi-agent planning (UNICAEN, Sapienza), multi-modal and short-term human-robot interaction (Sapienza, UNICAEN).

Relevance:

COACHES project is relevant to the main objective of CHIST-ERA, call AMCE. COACHES is dedicated to design a multiple services autonomous multi-robot system evolving in public areas. These systems will be deployed in public areas such as Malls and touristic sites where the environment is complex and could be overcrowded requiring a strong and robust abilities of navigation, recognition and assistance. To this end, COACHES will develop a research addressing the following topics targeted by the AMCE call: - Dealing with uncertainty + Multi-robot planning with uncertainty using POMDPs + Use of belief nets and extended hidden Markov models for recognition + Probabilistic reasoning for visual perception - Knowledge representation and reasoning + Common sense and spatial knowledge representation and reasoning; non-monotonic reasoning + Probabilistic reasoning using Bayes-Net for belief revisions to detection and recognition - Embodiment, perception, cognition, interaction + Short-term human-robot interaction and multi-modal interface + Embodied intelligence + multi-target tracking & behaviour recognition - Coordination and learning + Coordination and communication strategies of robots to cooperate and to interact with humans + Multi-agent planning under uncertainty to share tasks of the patrolling and assistance mission + Learning from many short-term interactions to improve assistance to visitors