



# chist-era

## **Deliverable Number 6.5**

Call 2022 Topics Selection



|                             |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              |                                                            |                                                                          |
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| <b>Workpackage</b>          | 6                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            |                                                            |                                                                          |
| <b>Subtask</b>              | 6.2                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          |                                                            |                                                                          |
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| <b>Type of deliverable</b>  | Report                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       |                                                            |                                                                          |
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| <b>EC project officer</b>   | Salvatore Spinello                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           |                                                            |                                                                          |
| <b>Publishable abstract</b> | <p>The report describes the procedure for the selection of the topics for the CHIST-ERA Call 2022. To identify candidate topics the CHIST-ERA partners and the Scientific Advisory Board were invited to propose topics. Additionally, an open consultation was organized to collect research topic ideas from research communities. This resulted in a list of 17 elaborated candidate topics. Those topics have been discussed in a first joint workshop, where 6 topics were pre-selected. Those 6 topics were further elaborated, analyzed and discussed during a 2<sup>nd</sup> workshop. On basis of a voting during the 2<sup>nd</sup> Workshop the CHIST-ERA Steering cCommittee has selected the following two topics for CHIST-ERA Call 2022:</p> <ol style="list-style-type: none"> <li>1. Security and Privacy and Decentralised and Distributed Systems (SPiDDS)</li> <li>2. Machine Learning-based Communication Systems, towards Wireless AI (WAI)</li> </ol> |                                                            |                                                                          |
| <b>Keywords</b>             | Call scientific scope – Call topics – Selection procedure                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    |                                                            |                                                                          |

## Executive Summary

The scientific scope of CHIST-ERA is wide, but the intention is to select focused, emergent topics of common interest. CHIST-ERA partners and the Scientific Advisory Board (SAB) were invited to propose topics. Additionally, an open consultation was organized to collect research topics from research ecosystem and general public. Topic proposers were asked to use a topic suggestion form and provide a short description, a set of application sectors and keywords for the topic. Further, they were asked to provide a rationale based on the scientific interest and innovation potential of the topics and the suitability of the topic for a CHIST-ERA call. This resulted in a list of 17 elaborated candidate topics.

The elaborated topic descriptions were distributed to the CHIST-ERA consortium and the SAB. During a first topic selection workshop strengths and weaknesses of each topic were discussed by the SAB and CHIST-ERA representatives. On basis of the discussion and a voting a pre-selection was made of 6 topics with the best potential to be selected as topics for the CHIST-ERA Call 2022. The pre-selected topics were further analysed and the SAB and the CHIST-ERA representatives were asked to score the 6 topics. In a 2<sup>nd</sup> Workshop the results of the analysis and scoring were presented, and the topics were further discussed. At the end of the Workshop, a voting was organized to select the two topics for the CHIST-ERA Call 2022.

This resulted in the selection of the following two topics for CHIST-ERA Call 2022:

- 1) Security and Privacy and Decentralised and Distributed Systems (SPiDDS);
- 2) Machine Learning-based Communication Systems, towards Wireless AI (WAI).

The outcome of this process serves as an input for the preparation of a strategic workshop, where the scientific text for the joint call is further developed.

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## Introduction

The CHIST-ERA topic selection process for the Call 2022 is based on the procedure and topic selection form developed in previous CHIST-ERA calls. In this deliverable: the topic selection procedure and the criteria used to discuss and select the topics for the CHIST-ERA call 2022 are described; the candidate topics proposed are presented; and the results of the voting process and the outcomes of the workshop are discussed; finally, the two topics selected are presented.

The outcome of this process serves as an input for the preparation of a strategic Conference, where the scientific text for the joint call is further developed.

## Topic identification

CHIST-ERA partners and the SAB were invited to propose topics for CHIST-ERA Call 2022. Additionally, an open consultation was organized to collect research topics from research ecosystem and general public<sup>1</sup>. The latter needed to be addressed to one of the funding organisations participating in CHIST-ERA, to assess the opportunity to include it as candidate topic for the CHIST-ERA Call 2022.

Topic proposers were asked to use a topic suggestion form and provide a short description, a set of application sectors and keywords for the topic. Further, they were asked to describe the scientific interest and innovation potential of topic (the state-of-the-art, missing science, and expected outcomes) and the Suitability of topic for a CHIST-ERA call (need for transnational cooperation, complementarity with existing calls, and suitability of topic size).

In case further elaborations or clarifications were needed, topic proposers were contacted and giving the opportunity to modify the topic description in the form.

The template for the topic suggestion is included in Annex C of this report.

Based on the suggestion of CHIST-ERA partners, SAB and the open consultation a list of 17 topic proposals was established. The table below gives an overview of the title, and proposers of the topics. A short description of each topic can be found in Annex D of this report.

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<sup>1</sup> [Open Consultation on Call 2022 Topics | CHIST-ERA \(chistera.eu\)](https://chistera.eu/open-consultation-on-call-2022-topics)

Table: list of 17 topic proposals

| Topic Id | Proposed by                 | Topic Suggestion                                                                                                                  |
|----------|-----------------------------|-----------------------------------------------------------------------------------------------------------------------------------|
| 1        | UEFISCDI                    | Addressing social and economic dimensions of Industry 5.0 through innovative approaches in implementing its specific technologies |
| 2        | AKA                         | Security and Privacy in Decentralised and Distributed Systems                                                                     |
| 3        | EPSRC-UKRI                  | Material Computing                                                                                                                |
| 4        | EPSRC-UKRI                  | Self-Aware Autonomous Systems (or just Self-Aware Systems)                                                                        |
| 5        | NCN                         | Human oriented interfaces for digital services (e-services) (InterDigit)                                                          |
| 6        | NCN                         | ICT for Embodied Intelligence                                                                                                     |
| 7        | EPSRC-UKRI                  | Facilitating an effective transition to evolving energy generation and usage.                                                     |
| 8        | Open Consultation (FNRS)    | Prescriptive analytics for robust and sustainable Industry 4.0 operations                                                         |
| 9        | Taiwan - MOST               | Nano-Opto-Electro-Mechanical Systems Based on Emerging Compound Semiconductors for ICT                                            |
| 10       | SNSF                        | Novel Research Data Infrastructures                                                                                               |
| 11       | Open Consultation (SNSF)    | COPHYDIR-SC: CONvergence of PHYsical and Digtal Realities through Spatial Computing                                               |
| 12       | AEI                         | Collective Memories                                                                                                               |
| 13       | TACR                        | Artificial Intelligence in the Context of Regional Growth and Development                                                         |
| 14       | Israel Innovation Authority | Machine Learning techniques for applications in modern communication                                                              |
| 15       | NCN                         | Debating Technologies for Trustworthy AI in E-Deliberation (DebTech)                                                              |
| 16       | Open Consultation (AEI)     | Wireless power transfer for remote systems and IOT applications                                                                   |
| 17       | Open Consultation (AEI)     | Highly efficient nano-thermoelectric systems (HENTS)                                                                              |

## Topic Selection

### First topic selection workshop

The objective of the first topic selection workshop was to pre-select 4-6 topics for further elaboration and analysis. Before the workshop, the topic selection forms submitted by the topic proposers were distributed to the SAB and the CHIST-ERA consortium. During the workshop, the topic proposers were asked to give a short introduction of the topic. After that, the strengths and weaknesses of each topic were discussed by the SAB and CHIST-ERA representatives. After each topic had been discussed, each member of the SAB and CHIST-ERA representative were asked to select the five topics with the best Scientific interest and innovation potential, suitable for a CHIST-ERA Call.

The voting result was the following:

| Topic title                                                                                 | Nr. Votes<br>SAB | Nr. votes CHIST-ERA<br>representatives | Total |
|---------------------------------------------------------------------------------------------|------------------|----------------------------------------|-------|
| <b>Security and Privacy in Decentralised and Distributed Systems</b>                        | 7                | 10                                     | 17    |
| <b>Machine Learning techniques for applications in modern communication</b>                 | 7                | 9                                      | 16    |
| <b>Human oriented interfaces for digital services (e-services) (InterDigit)</b>             | 5                | 6                                      | 11    |
| <b>Collective Memories</b>                                                                  | 4                | 6                                      | 10    |
| <b>Self-Aware Autonomous Systems (or just Self-Aware Systems)</b>                           | 4                | 5                                      | 9     |
| <b>COPHYDIR-SC: CONvergence of PHYSical and Digital Realities through Spatial Computing</b> | 3                | 5                                      | 8     |
| <i>Material Computing</i>                                                                   | 1                | 6                                      | 7     |

After the voting, each SAB member was given the opportunity to give comments on their preferences and votes. Also, the CHIST-ERA representatives were given the opportunity to comment on the voting results.

After the discussion, it was proposed to select the six topics with the most votes from the SAB and the highest total votes. The topic material computing was among the six most voted topics of the CHIST-ERA representatives, but it was decided not to include it as candidate topic for the 2<sup>nd</sup> workshop. The selection of the six topics indicated in bold in the table above was approved by the CHIST-ERA representatives.

After the workshop, the selected 6 topics were further elaborated and analysed. Topic proposers were contacted and asked for further elaboration. They were provided with the comments from the first workshop to improve their topic description and prepare the presentation of their topic for the 2<sup>nd</sup> workshop.

## Second Topic selection workshop

After having received the updates and elaborations of the pre-selected six topics, the revised descriptions were distributed to the Scientific Advisory Board and the CHIST-ERA partners. They were asked to submit scores from 1-5 on the criteria “Scientific interest and innovation potential” and “Suitability for CHIST-ERA call” for each topic, using an Excel file and provide comments on the topics. The results of the scoring and comments received were the basis for discussion in the CHIST-ERA topic selection Workshop on the 27<sup>th</sup> of January 2022.

On basis of the voting of the CHIST-ERA partners and the SAB members, an average score for each topic was calculated. The scores of the CHIST-ERA partners and SAB were combined and an average for each topic was calculated. A combined ranking of the CHIST-ERA partners and the Scientific Advisory Board was compiled and presented in the workshop.

| Topic Id | Topic Id | Topic Suggestion                                                                     | SAB Average | RFO Average | Overall Average |
|----------|----------|--------------------------------------------------------------------------------------|-------------|-------------|-----------------|
| 1        | 1        | Security and Privacy in Decentralised and Distributed Systems                        | 4,06        | 4,17        | 4,11            |
| 2        | 4        | COPHYDIR-SC: CONvergence of PHYSical and Digital Realities through Spatial Computing | 3,67        | 3,73        | 3,70            |
| 3        | 6        | Machine Learning techniques for applications in modern communication                 | 3,72        | 3,58        | 3,65            |
| 4        | 5        | Collective Memories                                                                  | 3,50        | 3,31        | 3,40            |
| 5        | 3        | Human oriented interfaces for digital services (e-services) (InterDigit)             | 3,39        | 3,38        | 3,39            |
| 6        | 2        | Self-Aware Autonomous Systems (or just Self-Aware Systems)                           | 3,06        | 3,62        | 3,34            |

The results of the voting were discussed in the 2<sup>nd</sup> CHIST-ERA Call 2022 topic selection online workshop on the 27<sup>th</sup> of January 2022, with the participation of the SAB and CHIST-ERA representatives.

During the workshop, the topics were discussed on basis of the order of the ranking, starting with the lowest ranked topic. The revised 6 topics were introduced by the topic proposers, highlighting the changes that were made compared to the first workshop. Strengths and Weaknesses were presented on basis of the comments received with the voting. SAB members and CHIST-ERA representatives were given the opportunity to comment on the topics.

After all topics were presented and discussed, SAB members were asked to vote for the two topics that they would like to have selected for the CHIST-ERA Call 2022. After the first voting round of the SAB members the topics: Self-Aware Autonomous Systems; Collective Memories; and Human oriented interfaces for digital services (e-services) (InterDigit) were discarded.

Subsequently, each CHIST-ERA partner was asked to vote for the two topics, out of three, they would like to have selected for the CHIST-ERA Call 2022. As a result, “Security and Privacy in Decentralised and Distributed Systems” with 12 votes and “Machine Learning techniques for applications in modern communication” with 9 votes were selected as the two topics for the CHIST-ERA Call 2022.

The voting result was the following:

| Topic title                                                                          | Nr. Votes<br>SAB | Nr. votes CHIST-ERA<br>representatives | Total |
|--------------------------------------------------------------------------------------|------------------|----------------------------------------|-------|
| Security and Privacy in Decentralised and Distributed Systems                        | 6                | 12                                     | 18    |
| Machine Learning techniques for applications in modern communication                 | 6                | 9                                      | 15    |
| COPHYDIR-SC: CONvergence of PHYsical and Dlgital Realities through Spatial Computing | 4                | 8                                      | 12    |
| Human oriented interfaces for digital services (e-services) (InterDigit)             | 1                |                                        | 1     |
| Collective Memories                                                                  |                  |                                        |       |
| Self-Aware Autonomous Systems (or just Self-Aware Systems)                           |                  |                                        |       |

The topics “Security and Privacy in Decentralised and Distributed Systems” and “Machine Learning techniques for applications in modern communication” were, in cooperation with the topic proposer, further prepared for publication. A small paragraph and keywords have been prepared for each topics for publication on the CHIST-ERA website, taken into account comments and issues raised during this workshop.

## Conclusion

On basis of the votes and the workshop discussions, the CHIST-ERA Steering Committee has selected two topics for the CHIST-ERA Call 2022 with the following descriptions and key words:

### **Topic 1. Security and Privacy and Decentralised and Distributed Systems (SPiDDS)**

Due to several technical trends (e.g., increasing miniaturisation of computing devices and availability of massive hardware parallelism in data centers) as well as societal ones (e.g., increasing globalisation and sharing of information), more and more computer applications are decentralised or distributed these days. This shift exacerbates security and privacy issues in computer systems, especially with applications becoming more complex by spanning multiple tiers or hardware infrastructures, and integrating different subsystems and components. New approaches are needed to achieve and reason about security and privacy guarantees in a comprehensive end-to-end fashion in such applications. In particular, formal techniques for verifying properties are needed for increasing automation and rigor in the face of increasingly complex systems.

**Application sectors:** Blockchains, edge and fog, 5G / 6G applications and systems, IoT, cloud

**Keywords:** Security, privacy and trust in distributed systems; Secure mobile, edge and cloud computing; Formal models of security and privacy; Automated verification of security and privacy properties in software; Secure distributed ledgers and coordination

### **Topic 2. Machine Learning-based Communication Systems, towards Wireless AI (WAI)**

We are facing large growth in IoT networks and data traffic. New service requirements become also more and more demanding: Higher data volumes, ultra-low latency, massive connectivity, higher reliability and lower power consumption. To meet these requirements and dynamicity of the network, next generation wireless networks push forward towards radically new approaches. Machine Learning techniques can help future networks to meet these requirements and dynamicity of the network. They have the potential to handle giant amount of information to outperform current application scenarios and deliver novel ones. A partial list of components that could be significantly enhanced using Machine Learning techniques are: Resource optimization in Radio Access Network (scheduling), physical layer signal processing, spatial (MIMO) processing & beamforming, spectrum sensing & spectrum access for Cognitive Radio Networks, learning at the edge of wireless networks. The call topic will aim at accelerating the path towards relevant Wireless AI by successfully integrating software-based solutions and hardware-oriented proof-of-concepts.

**Application sectors:** Communication systems, AI

**Keywords:** Wireless communication, Machine Learning, Radio Access Networks, signal processing, MIMO, spectrum sensing, Cognitive Radio Networks, 5G, optimization algorithms, Dynamic Spectrum Allocation

## Annexes

### A. SAB (Scientific Advisory Board)

#### SAB

| Member                 | Institution                                 | Country                  |
|------------------------|---------------------------------------------|--------------------------|
| Elisabeth André        | Augsburg University                         | Germany                  |
| Sharon Sputz           | Columbia University                         | United States of America |
| Siobhán Clarke         | Trinity College Dublin                      | Ireland                  |
| Didier Galmiche        | University of Lorraine                      | France                   |
| Eero Hyvönen           | Aalto University and University of Helsinki | Finland                  |
| Yiannis Kompatsiaris   | Center for Research and Technology - Hellas | Greece                   |
| Teresa Zielińska       | National Science Centre (NCN)               | Poland                   |
| Begoña García-Zapirain | University of Deusto                        | Spain                    |
| Patrick Eugster        | Università della Svizzera italiana          | Italy                    |
| Philippe Cudré-Mauroux | University of Fribourg                      | Switzerland              |
| Guillaume Ducournau    | University of Lille                         | France                   |

## B. Topic selection timeline for Call 2022

### Timeline for topic selection CHIST-ERA Call 2022

|                                |                                                                                                      |                                       |
|--------------------------------|------------------------------------------------------------------------------------------------------|---------------------------------------|
| <b>End of September 2021</b>   | <b>Opening public Consultation/<br/>RFO and SAB called to propose<br/>topics</b>                     | <b>AEI</b>                            |
| <b>5 November 2021</b>         | <b>Deadline to submit topic<br/>proposals</b>                                                        | <i>CHIST-ERA partners and<br/>SAB</i> |
| <b>8 November 2021</b>         | <b>Publication list of topic proposals<br/>and call for votes</b>                                    | <b>AEI</b>                            |
| <i>2 weeks</i>                 | <i>Topic voting and feedback</i>                                                                     | <i>CHIST-ERA partners and<br/>SAB</i> |
| <b>18 November 2021</b>        | <b>Deadline for votes/ feedback</b>                                                                  | <b>RFOs and SAB</b>                   |
|                                | <i>Analysis of voting results</i>                                                                    | <i>AEI</i>                            |
| <b>23th of November</b>        | <b>1<sup>st</sup> workshop to discuss topics and<br/>voting results; pre-selection of<br/>topics</b> | <b>CHIST-ERA partners and<br/>SAB</b> |
|                                | <i>In-depth analysis of pre-selected<br/>topics; additional input of topic<br/>proposers</i>         | <b>AEI</b>                            |
| <b>27<sup>th</sup> January</b> | <b>2<sup>nd</sup> workshop to select two<br/>elaborated topics for CHIST-ERA<br/>Call 2022</b>       | <b>CHIST-ERA partners and<br/>SAB</b> |
| <b>Beginning of February</b>   | <b>Publication of topics CHIST-ERA<br/>Call 2021</b>                                                 | <b>CHIST-ERA SC</b>                   |

### C. Template for topic suggestion

## CHIST-ERA Call 2022 Topic suggestion

Please send this form back to [era-ict@aei.gob.es](mailto:era-ict@aei.gob.es)

### Proposer

|                                 |  |
|---------------------------------|--|
| <b>Institution / Initiative</b> |  |
| <b>Contact(s)</b>               |  |

### Topic definition

|                                          |  |
|------------------------------------------|--|
| <b>Topic title</b><br>(2-10 words)       |  |
| <b>Short description</b><br>(max ½ page) |  |
| <b>Application sectors</b>               |  |
| <b>Keywords</b>                          |  |

### **Scientific interest and innovation potential of topic**

*Describe the state-of-the-art, missing science, and expected outcomes (max 1/2 page).*

- *Describe how the topic can support the exploration of bold ideas for radically new technologies based on high-risk / high gain cutting-edge science*
- *Describe how knowledge and communities from different disciplines can be brought together*
- *Describe how scientific and technological performance can be objectively measured in the area (measurement methods, metrics, tools, infrastructures, ...)*
- *Describe how research results can be transformed into innovations with societal or economic impact*

### **Suitability of topic for a CHIST-ERA call**

*Describe the need for transnational cooperation, complementarity with existing calls, and suitability of topic size (max 1/2 page)*

- *Describe how transnational cooperation in the framework of a joint call can bring added value (complementary national scientific strengths, need for critical mass, need for joint infrastructures, ...)*
- *Describe closest calls (EIC Pathfinder, Horizon Europe, H2020, ERA-NETs, ...) and how the topic complements and/or leverages them (the topic should not be redundant with other calls)*
- *Describe how a significant contribution in the area can be obtained with a call of a few M€, possibly giving indications about the size of the main events, initiatives or structures in the area (conferences, programmes, teams, centres, professional associations, ...).*

## D. List of topic proposals

| E. Topic                                                                                                                          | Description                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       | Proposed by |
|-----------------------------------------------------------------------------------------------------------------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-------------|
| Addressing social and economic dimensions of Industry 5.0 through innovative approaches in implementing its specific technologies | <p>The proposal is mainly based on Müller, Julian. Enabling Technologies for Industry 5.0. Results of a workshop with Europe's technology leaders. European Commission, Directorate-General for Research and Innovation, Unit F5 Industry 5.0, September 2020, ISBN 978-92-76-22048-0, CC-BY 4.0, DOI: 10.2777/082634 and P.K.R. Maddikunta et al., Industry 5.0: A survey on enabling technologies and potential applications. Journal of Industrial Information Integration, August 2021 DOI: 10.1016/j.jii.2021.100257. Industry 5.0 is considered an evolution and logical continuation of the existing Industry 4.0 paradigm focused on such values as human-centricity, ecological or social benefits. Technologies in Industry 5.0 must be regarded as part of systems that are actively designed towards empowering societal and ecological values. The core idea behind Industry 5.0 is to choose technologies based on an ethical rationale of how those support human values and needs, and not only based on what they can achieve from a purely technical or economic perspective. Merging human and technological skills and strengths to the mutual benefit of industry and industry workers allows safer, more satisfying and more ergonomic working environments, in which humans can use their creativity in problem-solving, adopt new roles, and enhance their skills. The products and services of Industry 5.0 should be further customised to user's needs, should reduce environmental impact and allow concepts such as closed loops, energy self-sufficiency, emission-neutrality, or the Circular Economy. The social dimension of Industry 5.0 includes: technology acceptance and trust in technologies, training people how to use new technologies, retraining and lifelong learning to cope with upcoming labour and skills shortages, forging a 'new deal' between society and industry to address youth unemployment, ageing society or gender and societal inequality, full integration of customers across the entire value chains to inform them about social or environmental value created, measure and quantify environmental and social value generated. The social dimension of Industry 5.0 includes: technology acceptance and trust in technologies, training people how to use new technologies; retraining and lifelong learning to cope with upcoming labour and skills shortages; forging a 'new deal' between society and industry to address youth unemployment, ageing society or gender and societal inequality; full integration of customers across the entire value chains to inform them about social or environmental value created; measure and quantify environmental and social value generated.</p> | UEFISCDI    |

|                                                               |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       |            |
|---------------------------------------------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------------|
| Security and Privacy in Decentralised and Distributed Systems | Increasing data volumes and easier access to numerous computational resources through different communication channels have created an opportunity to diversify the implementation of computation and to decentralise the management of systems, networks and services. Distributed architecture makes scalability much simpler, as new devices can be added and configured to networks without major interference. Consequently, the use of different decentralised approaches is constantly increasing in different systems. Distributed computing improves the privacy of data processing and data networks, and it is usually less sensitive to errors and also provides faster access to data. A decentralised system is typically also more fault-tolerant, more transparent and more secure, and it improves resource allocation. However, the maintenance of decentralised systems is often more complex, and they may become more prone to cyberattacks as well as data leaks and breaches. They are exposed to the same data security threats and risks as more centralised systems and their users. This covers, for example, access control, encryption, data-flow vulnerabilities, data-transfer mechanisms, middleware resources, and decentralised and distributed applications. The present call focuses on advanced information security solutions that are suitable for distributed and decentralised systems in order to make them, as well as the resulting networks and services, more reliable. | AKA        |
| Material Computing                                            | Material Computing describes computing implemented in novel material systems, directly exploiting the material structure and dynamics to compute. Such materials include meta-materials: magnetic, mechanical, MEMS, and other engineered systems. The topic includes implementations and evaluation of material computer, and the associated novel computational models, logics, programming and verification. Classical computers, although powerful in terms of raw processing capabilities, lack the adaptability, resilience and flexibility of such systems, which can also often run at much lower powers. The challenge is not to compete with existing silicon-based processor architectures, but to identify and exploit additional or previously unobtainable benefits of using non-standard materials, including hybrid systems comprising multiple materials, for novel contexts and applications, e.g., low power, edge computing, adaptive sensing and control, hostile environments).                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 | EPSRC-UKRI |
| Self-Aware Autonomous Systems (or just Self-Aware Systems)    | Modern complex systems, especially those expected to act independently, must be able to assess their own actions and capabilities and then manage and evolve their behaviour as needed. This is especially important where there is no direct human control, either because of distance from the system (and so, communication delays and lack of situation awareness) or complexity of the target scenarios (too many independent elements, moving too fast, or acting unpredictably). In these autonomous systems, software must make key decisions, often of a critical nature. To do this effectively, the system must have a clear view of its state and its capabilities. The core aspect here is self-awareness. Self-awareness about a system's capabilities, about its condition, about its targets for action, about potential dangers, etc. By endowing sophisticated systems with elements of self-awareness, they are able to make better, and more effective, decisions, thus providing the system with stronger, and more reliable, routes to key requirements such as predictability, sustainability, explainability, verifiability, efficiency and fault tolerance.                                                                                                                                                                                                                                                                                                                                  | EPSRC-UKRI |

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| Human oriented interfaces for digital services (e-services) (InterDigit) | <p>Aim of the call is to rise the human-machine interfaces (used in computer, mobile phone applications, automatons, robots) to a new technological level. Nowadays, people are interacting with technology using increasingly intelligent interfaces, moving from traditional keyboards to touch screens, voice commands and other communication methods. However still the digital interfaces and chatbots are using rather simple and standard tools. The applied solutions are just sufficient, but not obviously the most convenient. Advanced and promising embodiments of human-machine interfaces should be explored aiming at user friendly and intelligent broadly defined digital services in public and private sectors. It is expected that not only typical methods of artificial intelligence will be applied, but a break-through will be made using the fusion of diverse information processing and reasoning approaches, focusing on combining natural means of communication (e.g., speech, gesture, emotion, touch). The limitations of Question Answering Systems leveraging on Natural Language Processing should be overcome. The research will also require involvement of novel and inexpensive sensors incorporated into human-machine interfaces. It should consider the broad range of interfaces including those for the e-commerce, digital health systems, interfaces to human robotic assistants etc. economic impact. The topic is naturally multi- and interdisciplinary. It requires cooperation of specialists from the field of artificial intelligence, natural language processing, machine vision, signal processing, specialists in information sciences, psychology, robotics, sensing techniques, communication technologies, ergonomics, human safety, cyber-security, marketing sciences and e-commerce as well. Such multidisciplinary cooperation has a high innovation potential. The topic requires fundamental research however it should lead to the methods and tools which will be later used in applications. The research should consider (but not only) the potential of: - biometrics, - neurofeedback (e.g., intelligent headsets), - voice and gesture commands, - emotion recognition, - multi-sensory sets involving the sensors not yet commonly applied in the interfaces (e.g., temperature, motion sensors, gaze following), - haptic gloves, - smart glasses.</p> | NCN |
| ICT for Embodied Intelligence                                            | <p>Embodied intelligence is an approach to the design and understanding of intelligent behavior in embodied and situated agents through the consideration of strict coupling between the agent and its environment (situatedness), mediated by the constraints of the agent's own body, perceptual and motor system, and brain (embodiment). The emergence of the field of embodied intelligence is closely linked to parallel developments in computational intelligence and robotics. This call focuses on the efficient and novel methods for intelligent motion design assuring the autonomous actions of embodied agents. The agents should be able to improve their capabilities through self-learning and self-improving. The agents will gain the capabilities for performing safely and reliably useful actions with overcoming successfully unexpected situations. It is assumed that the proposed solutions will be inspired and supported not only by engineering but also by biology, neuroscience, and cognitive sciences. Morphological computations (in morphological computations certain processes are performed by the body that otherwise would have to be performed by the brain) can also be taken into account. Diverse intelligent effector systems, including robots, should be treated as implementation devices.</p>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      | NCN |

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| Facilitating an effective transition to evolving energy generation and usage. | Increases in renewable energy generation are vital in meeting internationally agreed climate targets. However renewable energy generation both at macro (e.g. hydroelectric) and micro (e.g. domestic solar) scales are affected by both long term seasonal changes and short term extreme weather events, causing unpredictable fluctuations that can impact the ability to maintain a stabilised power network at national and international scales. Concurrently, the anticipated shift to electric vehicles and related charging infrastructure will create changes in consumer energy demand associated with a rise in large scale battery storage in automotive and domestic settings. These electrical storage vectors may therefore present opportunities in both accommodating excess energy production and in supplementing energy demand. However the implementation, control, cost and regulation of such technologies at macro and micro scales can at present be challenging to achieve. Furthermore, the increasing connectivity of more and more cyber-physical devices can present additional cybersecurity vulnerabilities as well as where data driven decision making processes reside (e.g. Cloud vs. Edge).                                                                                                                                                                                                                                                                                                                                 | EPSRC-UKRI               |
| Prescriptive analytics for robust and sustainable Industry 4.0 operations     | With the emergence of Industry 4.0, companies are facing a digital transformation enabled by the deployment of sensors, digital twins and the availability of massive data streams collected in real-time. The predictive power of machine learning techniques have pushed further the potential usage of these data. However, the use of data is often limited to descriptive and predictive analytics techniques. Uncertainties in the global and dynamic environment, as highlighted by the recent pandemic, must be taken into account in the decision support process of Industry 4.0 companies. This requires the use of new prescriptive analytics techniques involving robust optimisation and real-time re-optimisation of the production process to face critical events, with sustainability and scalability as a main target. Indeed, descriptive analytics has the function of describing, diagnosing, and discovering trends and patterns. Predictive analytics has the function of predicting events that can occur in the future. While prescriptive analytics has the function of prescribing optimal actions in particular to reduce the chance of an unwanted event based on the prediction. Efficient and scalable algorithms combining artificial intelligence methods for prediction and high-end optimisation techniques will be a key ingredient to make the transition to Industry 4.0 efficient and sustainable. There is a real challenge for dynamic environments and critical sectors like chemical or pharmaceutical manufacturing. | Open Consultation (FNRS) |

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| <p>Nano-Opto-Electro-Mechanical Systems Based on Emerging Compound Semiconductors for ICT</p> | <p>Nano-opto-electro-mechanical systems (NOEMS) offers unprecedented opportunities to control the flow of light in nanophotonic structures at high speed and low power consumption. The conceptual and technological advances from the field of optomechanics have the potential to create highly efficient, low-noise transducers between microwave and optical signals, in both the classical and the quantum domains for information and communications technology (ICT). Recent advances in new semiconductor compounds and integration technologies with processing chips can further enhance NOEMS to realize ultra-high-speed and low-power-consumption chips for advanced ICT applications. expected outcomes: Miniaturisation of NOEMS and integration with active devices in silicon electronics and/or photonics; Development of NOEMS using new semiconductor compounds; Development of metamaterials/metasurfaces for integration of NOEMS components. Projects are expected to contribute to the following outcomes: Develop a deeper fundamental and comprehensive understanding of NOEMS for information and communication technologies; Develop new NOEMS devices and systems using emerging semiconductor compounds; Develop integrated NOEMS systems and chips for ICT</p>                                                                                                                                                                                                                                                                                   | <p>Taiwan - MOST</p>            |
| <p>Novel Research Data Infrastructures</p>                                                    | <p>Open Research Data is increasingly viewed as a necessary step towards promoting technology and science in Europe. While the main principles (e.g., FAIR) are now well established, Europe is still lack infrastructures to make this vision a reality. Although many data repositories are currently emerging, they are typically operating as data silos and are not promoting global interoperability. Also, most platforms that are being used today were actually developed years or even decades ago and are lacking technologically, with outdated storage, networking, and indexing capabilities. This topic would directly address those issues by promoting pan-European systems to store, index and share open research data in more scalable and effective ways. Among other endeavors, the following infrastructures could be envisioned: Next-generation data storage systems taking advantage of modern hardware (e.g., next-generation SSDs, FPGAs or heterogeneous computing platforms) to store, index and query very large datasets efficiently; Next-generation networking platforms taking advantage of smart NICs and/or programmable switches to serve large-scale scientific data at line-rate (e.g., several GB/s); Middleware to index and compare raw scientific data in addition to rich metadata, and to interlink open research data across repositories; Search engines providing advanced search capabilities to pan-European data, supporting advanced features such as raw data search, natural language queries, or similarity search.</p> | <p>SNSF</p>                     |
| <p>COPHYDIR-SC: CONvergence of PHYSical and DIGital Realities through Spatial Computing</p>   | <p>Extended Reality (XR) applications are becoming part of our daily life, boosted by advancements in network, cloud and AI technologies. Blending virtual and physical realities, referred to as Spatial Computing (SC), will create many technical, sustainability, social, and ethical challenges. For instance, privacy issues related to user actions tracking (including body posture and gaze) and energetical impact of providing SC, need to be considered carefully. On the other hand, SC will provide more realistic interactions and would highly benefit social life when physical presence is not possible. This calls for advanced research on technologies, sustainability and social impact of SC.</p>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        | <p>Open Consultation (SNSF)</p> |

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| Collective Memories                                                       | The 1950/1960s have seen a vast proliferation and democratization of analog photography. Likewise, the 1970s have seen a similar development with analog home video. In the last years, several attempts to digitize and thus to preserve this content have been undertaken. However, detailed meta information on the content of the media objects and in particular on the context of this content is needed. Otherwise, the further use of digitized objects would be significantly limited. Today, substantial time is spent to index content, so that it becomes accessible in repositories. Without further activity, much of the cultural heritage of the people, events, places and traditions shown in these images and videos would be irrevocably gone, together with the generation having the knowledge on all these details. Therefore, the knowledge of contemporary witnesses is essential for the index work. The preservation of the cultural heritage contained in such multimedia collections necessitates approaches from machine learning for detecting objects in single images, image clusters, and videos together with their spatial relationships, but also advanced (location- and profile-aware) crowdsourcing mechanisms and appropriate user interfaces for the collection of further meta information at large scale. Since existing knowledge bases and open data on places, people, events, or traditions already exist, approaches to entity recognition and linking and the integration of such data sources and knowledge bases using semantic technologies and interoperability are highly important as well for this topic. | AEI                         |
| Artificial Intelligence in the Context of Regional Growth and Development | Artificial Intelligence (AI) is considered to be the ability of a machine to pretend human-like capabilities such as reasoning, learning, planning and creativity. It enables technical systems to realize their environment, deal with what they perceive, solve problems and act to achieve a specific goal. Based on the growing importance and potential of AI, there is a need to define the opportunities and benefits of AI for public services while contributing to regional growth and development, bringing a significant improvements in the management and solving local issues for the communities and the environment. An excellent research project on finding the AI solutions should contribute to sustainable national and regional growth and development and to be in line with the Sustainable Development Goals, the European Green Deal and the Digital Decade ambitions. The project should increase Europe's competitiveness through the use of AI and find solutions to regional challenges in the sectors of 1. infrastructure, mobility and urban planning; 2. management of natural disasters and the prevention of environmental and social risks. A solver should focus on a concrete national or regional problems and find innovative solutions through the means of AI testing. The cooperation between the public, academic and private sectors should be involved. The outcome will contribute to a comprehensive solutions supporting Europe-wide competitiveness, regional growth and development through artificial intelligence.                                                                                          | TACR                        |
| Machine Learning techniques for applications in modern communication      | 1) Wireless communication. A partial list of modules that could be significantly enhanced using ML techniques is presented below: Scheduler of wireless base station; Physical level signal processing; Spatial (MIMO) processing & beamforming; Spectrum sensing & cognitive radio capabilities. 2) Optical communication (including coherent optical communication). 3) Radar. E.g. - capabilities for enhanced detection & tracking .                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           | Israel Innovation Authority |

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| <p>Debating Technologies for Trustworthy AI in E-Deliberation (DebTech)</p> | <p>In April 2021, the European Commission announced a new priority of turning Europe into a global hub for trustworthy Artificial Intelligence (AI) [1]. According to the Executive Vice-President for a Europe fit for the Digital Age: On Artificial Intelligence, trust is a must, not a nice to have. By setting the standards, we can pave the way to ethical technology worldwide and ensure that the EU remains competitive along the way. Future-proof and innovation-friendly, our rules will intervene where strictly needed: when the safety and fundamental rights of EU citizens are at stake. Increasingly, the barriers for the further development of AI move away from purely technological towards more human: ethics, governance and EU values. The application of ICT in deliberative democracy (cf. [2]) requires addressing challenges such as discrimination against people based on their nationality, age, gender or sex and social media spreading disinformation, polarisation or hate speech. Trust in AI is thus a must and a necessary step towards creating a Europe-wide online sphere of “public reason”. Debating technology, an emerging and rapidly growing area of AI [3,4,5], brings together research in computational argumentation, argument mining and dialogue systems to support and engage with human debating and public reason. By delivering online platforms for e-deliberation, the DebTech topic has a potential to significantly enhance a dialogue between citizens and governments and reinforce citizen involvement, paving the way to public trust in AI and institutions.</p> | <p>NCN</p>                     |
| <p>Wireless power transfer for remote systems and IOT applications</p>      | <p>Wireless power transfer (WPT) technology has attracted increasing interest, becoming a billion market within the last years, thanks to the increasing presence of remote data collection devices. This technology could allow to send power and data to remote systems which are not reachable. While there are several solutions available for short range distance applications, this is not the case for middle and large ranges. Nowadays, the power transfer efficiency is around 20% and the amount of power density that can be transferred to large distances is limited to 100Wcm<sup>-2</sup>. It is fundamental to increase the efficiency and power transfer considering new approaches, (technologies, designs and materials) to overcome these limitations. The design of highly efficient systems that transfer enough power to remote systems would allow to completely remove the batteries, expanding the communication capabilities, and increasing the lifetime of these systems, which will be also very beneficial environmentally. This high-risk/high-gain topic offers new disruptive solutions to power remote systems, being of great interest for remote sensors and actuators, telemetry, unmanned aerial and underwater vehicles, satellites, and industrial applications. It also creates a new technology avenue in advanced materials and devices and opens new domains of application.</p>                                                                                                                                                                                                        | <p>Open Consultation (AEI)</p> |

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| Highly efficient nano-thermoelectric systems (HENTS) | Thermoelectric devices, which transform heat into electricity or viceversa, are key to the generation of clean and green energy. Current solid-state thermoelectric devices (TE) are much faster and robust than typical ones, but have a very poor performance, which translates in rather low efficiencies. A way of increasing their performance is by nanostructuring, which can increase the thermoelectric response and reduce the thermal conductance, leading thus to much higher figures of merit. Current TE devices are not yet, however, efficient enough to achieve good enough performances due to small thermoelectric powers and large thermal conductances. In this Topic we propose the bottom-up design of efficient thermoelectric systems by taking advantage of recent developments in nanotechnology-related fields such as molecular electronics and 2D materials. | Open Consultation (AEI) |
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