

MISSIONE 4
ISTRUZIONE
RICERCA

FUTURE ARTIFICIAL INTELLIGENCE RESEARCH (HEREAFTER FAIR)

INTELLIGENZA ARTIFICIALE: ASPETTI
FONDAZIONALI



Finanziato
dall'Unione europea
NextGenerationEU



Ministero
dell'Università
e della Ricerca



Italiadomani
PIANO NAZIONALE
DI RIPRESA E RESILIENZA

Tematica: 1. Intelligenza artificiale: aspetti fondazionali

Obiettivi (*Sez A dell'Annex 1*)

Characteristics, objectives and motivations

The Coordinated Plan on Artificial Intelligence (launched in 2018 and revised in April 2021¹) puts forward a concrete set of joint actions for the European Commission and Member States on strengthening Europe's leading position in the development of human-centric, sustainable, secure, inclusive and trustworthy AI. The European Commission also released a legal framework on AI², which addresses the risks of AI and proposes proportionate and flexible rules to address the specific risks posed by AI systems, setting the highest standard worldwide. The National Strategic Program on AI (2022-2024)³, released by the Italian government in November 2021 coherently with the EU strategy on AI and the Intervention Area 4 of the Italian PNR (2021- 2027)⁴, sets for Italy the ambitious goal of becoming a global research and innovation hub of AI.

The plan is to:

- i) advance frontier research in AI, both for fundamental and applied research,
- ii) reduce AI research fragmentation,
- iii) develop and adopt human-centered and trustworthy AI in the public and private sector,
- iv) increase AI-based innovation and development of AI technology,
- v) develop AI-driven policy and services in the public sector, and
- vi) create, retain and attract AI talent.

This proposal for an extended partnership titled Future Artificial Intelligence Research (hereafter FAIR) is the response of the Italian AI scientific community to the National Strategic Program. FAIR takes on the challenge to set the agenda of frontier research for the AI methodologies and techniques of tomorrow. Over the course of the last decade, AI researchers have made groundbreaking progress in hard and longstanding problems related to machine learning, computer vision, speech recognition, and autonomous systems. Despite the success of AI, its adoption so far is mostly in low-risk applications, while the uptake in medium/high-risk applications, which might have a deeper transformative impact on our society, such as in healthcare, public administration, safety-critical industry etc., is still low compared to expectations. The reasons for such lagging are profound. Adoption barriers include perceived challenges to the autonomy and the oversight capacity of human users, the required effort, dissatisfaction with user interfaces and, above all, trust concerns related to poor users' knowledge about the assumptions, limitations and capabilities of AI systems. Lack of trust undermines the spread of innovations.

FAIR AMBITION: Well beyond currently available technologies, we need AI systems capable of interacting and collaborating with humans, of perceiving and acting within evolving contexts, of being aware of their own limitations and able to adapt to new situations, and interact appropriately in complex social settings, of being aware of their perimeters of security and trust, and of being attentive to the environmental and social impact that their implementation and execution may entail. In short, we need an AI that does not yet exist. This is why fundamental, multidisciplinary research is necessary to shape the AI of the future.

FAIR envisions new forms of AI that are:

1. human-centered: co-evolve with the human “in-the-loop”, at individual and collective level
2. integrative: bridge across the different AI methods, technologies, disciplines, and competences
3. resilient: operate in challenging, noisy, uncertain real-world settings
4. adaptive: perceive, learn and act in dynamically changing environments
5. high-quality: meet quality standards for high-risk, high-accuracy, safety-critical applications
6. symbiotic: promote effective human-machine interaction and collaboration
7. edge/exascale: operate at the infinitely small on the edge, and at the infinitely big on the cloud
8. pervasive: operate ubiquitously in different social settings
9. green-aware: consider the environmental dimension “by-design”
10. sustainable and bio-cognitive: mimic the principles of biological systems at multiple scales.

While these 10 themes will be the topics of 10 large spoke-projects, a number of fundamental scientific and technological challenges will be tackled with coordinated interspoke actions, called transversal projects - TP, where each involved spoke will contribute from its own specific perspective: (TP1) Legal and Ethical Design of Trustworthy AI Systems: how to create responsible, trustworthy AI “bydesign”, “in-design” and “for designers” (TP2) Vision, Language and Multimodal Challenges: how to create AI agents capable of perception in real, complex environments with multiple combined modalities (text, speech, images, video, ...) (TP3) Learning and Reasoning from Individual to Communities to Society: how to create AI agents that integrate learning and reasoning to assist decision making at multiple scales (individual, societal) (TP4) Adjustable Autonomy and Physical Embodied Intelligence: how to create autonomous AI systems capable to understand the limits of their autonomy, asking for human supervision when appropriate (TP5, TP6) Frontiers of Machine Learning: how to gear the methods of mathematics and physics to understand why and when machine learning works, and how to expand the frontiers of “lifelong”, continual, incremental learning and meta learning (learning to learn) (TP7) Data Centric AI and Infrastructures: how to manage, prepare and curate large, highquality data for AI development. The figure highlights the synergies among Spokes and Transversal Projects. The paradigm of TPs is a dynamic concept aimed at amplifying the synergies among spokes, providing the “humus” for further collaborations, so that, in the course of the program, new additional crosscutting challenges might be envisaged and new TPs will possibly emerge. While pursuing its ambitious scientific goals, FAIR intends to contribute significantly to the objectives set forth in the Italian Strategic Programme on AI. In short: O1 - Advance frontier research in AI: in order to foster its vision of AI for the future, FAIR will pursue fundamental research through the 10 thematic spokes, while the 7 transversal projects will leverage synergies among the spokes. FAIR aims at placing Italy among the top countries for the development of the next generation of AI theories and technology for sensory data interpretation, visual and language-based interaction between humans and machines, efficient learning strategies with large and small data, also in continual training and in non-Euclidean spaces, new methods of reasoning, inference and planning, neuroscience-informed machine learning, new techniques for auto-ML and self-programming machines, and new models hybridizing learning and knowledge-based methods. Top-ranked labs and scholars of multiple disciplines are committed to contributing to the spokes, bringing in the substantive interdisciplinary resources of FAIR. Thus, the core computer science and engineering competences in AI are complemented by mathematics, physics (TP5 is led by and includes scientists of these two communities), law, ethics and philosophy (TP1 is led by and includes

scientists of these three communities), social and economic sciences, cognitive and neuroscience expertise. In particular, FAIR will develop an ambitious research and innovation itinerary for the foundation of Future AI leveraging Italy and Europe's strengths and opportunities. FAIR will produce novel AI methods, benchmarking datasets, and prototypes. FAIR's spokes will also curate a live strategic research and innovation roadmap document, aimed at taking stock of the AI advancements.

O2 - Reduce AI research fragmentation, foster critical mass and inclusion: the current Italian scientific landscape in AI is fragmented, because many research groups work individually or in small constellations and relatively isolated scientific communities, thereby hampering the capacity for AI research in Italy to reach the critical mass and obtain higher impact and visibility. Bringing together various communities and ecosystems – across geographies, maturity levels, and disciplines – is necessary to reduce fragmentation and effectively use resources. To this aim, FAIR will create a network of excellent AI research spokes across Italy (see Fig. B.2) based on four powerful instruments: i) a basic research program to address grand challenges organized in 10 thematic spokes, with 7 transversal projects that will leverage synergies between the spokes (see Fig. A.1), ii) a cascading call plan to widen the community engaging with other AI actors, iii) a plan for active dissemination to the larger AI community, and iv) a network of collaboration activities promoting research exchanges, training materials and events, and joint PhD supervision.

O3 - Create human-centered, robust, trustworthy and sustainable AI: these are priorities of the EU AI agenda and the core topics of several FAIR spokes (see Fig. A.1). Spokes 1, 6, 8 focus on synergistic human-AI collaboration and trustable socio-technical systems of interacting people and AIs. Spokes 2, 3, 4, 5 aim at defining methods for operating in noisy, uncertain settings, that meet quality standards of safety in critical applications and in dynamically changing environments. Spokes 7, 9, 10 conduct foundational research to define a novel generation of AI systems and algorithms, in which – no matter the specific application domain – the green and bio-socio-cognitive dimensions are considered “by-design”. Six spokes contribute from different perspectives to transversal project TP1 dedicated to trustworthiness: with formal methods to provide and verify safety guarantees, with proactive by-design approaches to enforce regulation, with methods for measuring compliance with the forthcoming AI regulation. The transversal TP2, TP3 and TP4 will coordinate other inter-spoke activities aimed at studying methods respectively for synergistic human-AI collaboration and for regulating the autonomy of AI systems.

O4 - Foster AI-based innovation and development of AI technology: seven industrial champions of priority sectors of Industry, Public sector, Society, and Environment have been selected to be actively involved in the spokes' activities, aiming at boosting a “from-lab-to-market” approach having researchers and innovators working shoulder to shoulder on research prototypes on challenging use cases. Some of the hired postdocs will spend part of their time with the industrial affiliates. A plan of cascade calls will be explicitly targeted at the involvement of other stakeholders, from startups to SMEs, for realizing pilots of novel AI-based services. Furthermore, 93 companies and 19 startups and spin-offs have provided support letters).

O5 - Create, retain and attract AI talent in Italy: FAIR will promote education in AI, creating a new generation of holistic AI researchers and innovators, striving to make Italy capable of retaining talents and an attractive AI destination for qualified human capital from abroad. Coherently with the PNR (National Research Plan, system priority n. 5), FAIR will boost the idea of circular mobility of researchers, i.e., not only from Italy to abroad and from South to North, with a robust plan for early researcher positions (Fixed-term researchers and research fellowships) and PhD fellowships and specific quotas allocated to Southern institutions and to gender balance. Concerning doctoral education, FAIR will leverage and expand the National PhD program in Artificial Intelligence (www.PhD-AI.it), established in 2021 by six institutions that are affiliated with FAIR and involving 60+ universities and research centers.

Furthermore, FAIR will promote career opportunities for the early-stage researchers (postdoc and PhD) both into academia and public and private sectors and boost their entrepreneurship attitudes with focused actions. O6 - Ensuring the long-term sustainability of the FAIR Hub: the Hub of FAIR will adopt the form of a “Società consortile” to manage the project. FAIR’s Hub and Spokes will study the actions to maintain the Hub after the end of the project with a portfolio of services and the relative business plan; to this aim, an Innovation Manager will be appointed by the Hub, that will be in charge to formulate a technology transfer plan and the related policies coherently with the R&I roadmap developed by spokes. A further concrete step will be to engage, with a plan of dissemination events, interested organizations, also outside the consortium, for creating and maintaining a FAIR Community of potential stakeholders. So far, more than 90 companies, 19 startups and spin-offs have given their support to this proposal; iii) the Scientific Committee will boost the attraction of new funded projects within the EU, National and Regional competitive calls. The FAIR approach follows a holistic, multidisciplinary approach, aimed at a profound rethinking of the foundations of AI, that goes hand in hand with investigating the social impact of the new forms of AI. Depending on the course that the AI revolution takes, AI will either empower our ability to make more informed choices or reduce human agency; expand the human experience or replace it; create new forms of human activity or reduce jobs; help distribute well-being for many or increase the concentration of power and wealth in the hands of a few; expand or endanger democracy in our societies; help to fight the climate change or increase emissions. FAIR researchers aim at making AI part of the solution to the global social, economic, sanitary and environmental challenges, rather than part of the problem.

Partner

N TOTALE SOGGETTI: 27

Proponente: Consiglio Nazionale delle Ricerche

Partecipanti:

SOGGETTI PUBBLICI

Università

- Politecnico di Milano
- Politecnico di Torino
- Scuola Internazionale Superiore di Studi Avanzati
- Scuola Normale Superiore
- Università degli Studi di Bari Aldo Moro
- Università degli studi di Modena e Reggio Emilia
- Università degli Studi di Napoli Federico II
- Sapienza Università di Roma
- Consiglio Nazionale delle Ricerche
- Università della Calabria
- Alma Mater Studiorum Università di Bologna
- Consiglio Nazionale delle Ricerche
- Istituto Nazionale di Fisica Nucleare
- Università di Catania
- Università di Pisa

- Università di Trento

Organismi di Ricerca

- Sapienza Università di Roma
- Alma Mater Studiorum Università di Bologna
- Consiglio Nazionale delle Ricerche
- Istituto Nazionale di Fisica Nucleare

SOGGETTI PRIVATI:

Organismi di Ricerca

- Università Campus Bio-Medico di Roma
- Università Commerciale Luigi Bocconi
- Consorzio Interuniversitario Nazionale per l'Informatica
- Fondazione Bruno Kessler
- Istituto Italiano di Tecnologia

Imprese

- Bracco Imaging S.p.A.
- Deloitte Risk Advisory S.R.L S.B.
- Expert.ai S.p.A.
- INTESA SANPAOLO S.P.A.
- Leonardo S.p.A.
- Lutech S.p.A.
- STMicroelectronics s.r.l.

Gli Spoke

Spoke n. 1: *HUMAN-CENTERED AI*

Leader spoke: Università di Pisa

Affiliati allo spoke

- Scuola Normale Superiore
- Consiglio Nazionale delle Ricerche

Spoke n. 2: *INTEGRATIVE AI*

Leader spoke: Fondazione Bruno Kessler

Affiliati allo spoke:

- Università di Trento

Spoke n. 3: *RESILIENT AI*.

Leader spoke: Università Campus Bio-Medico di Roma

Affiliati allo spoke:

- Università degli Studi di Napoli Federico II
- Consiglio Nazionale delle Ricerche

Spoke n. 4: *ADAPTIVE AI*.

Leader spoke: Politecnico di Milano

Affiliati allo spoke:

- Università Commerciale Luigi Bocconi

Spoke n. 5: *HIGH-QUALITY AI*.

Leader spoke: Sapienza Università di Roma

Affiliati allo spoke:

- Consiglio Nazionale delle Ricerche

Spoke n. 6: *SYMBIOTIC AI*.

Leader spoke: Università degli Studi di Bari Aldo Moro

Affiliati allo spoke :

- Istituto Nazionale di Fisica Nucleare

Spoke n. 7: *EDGE and EXASCALE AI*.

Leader spoke: Politecnico di Torino

Affiliati allo spoke:

- Scuola Internazionale Superiore di Studi Avanzati

Spoke n. 8: *PERVASIVE AI*.

Leader spoke: Alma Mater Studiorum Università di Bologna

Affiliati allo spoke:

- Consiglio Nazionale delle Ricerche
- Istituto Nazionale di Fisica Nucleare

Spoke n. 9: GREEN-AWARE AI.

Leader spoke: Università della Calabria

Affiliati allo spoke:

- Consiglio Nazionale delle Ricerche

Spoke n. 10: SUSTAINABLE BIO-SOCIO-COGNITIVE AI.

Leader spoke: Istituto Italiano di Tecnologia

Co-leader spoke: Università di Catania

Affiliati allo spoke:

- Consiglio Nazionale delle Ricerche
- Istituto Nazionale di Fisica Nucleare

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