cini National Lab

+ + +

++

AI for Future Italy

Artificial Intelligence and Intelligent Systems

cini National Lab

The CINI Vision and Recommendations for Italian AI

The document *AI for Future Italy: The CINI Vision and Recommendations*, has been drafted by the National Lab CINI AIIS (Artificial Intelligence and Intelligent Systems), endorsed by DIS (Dipartimento di Informazioni per la Sicurezza) of the Italian Presidency of Council of Ministers.

Edited by:

Rita Cucchiara, DIEF
Università di Modena e Reggio Emilia
CINI – Lab. Nazionale AIIS

Fosca Giannotti, ISTI
Consiglio Nazionale delle Ricerche
CINI – Lab. Nazionale AIIS

Daniele Nardi, DIAG
Università di Roma “La Sapienza”
CINI – Lab. Nazionale AIIS

Roberto Navigli, DI
Università di Roma “La Sapienza”
CINI – Lab. Nazionale AIIS

With the collaboration of the Lab CINI AIIS Steering Committee and with delegates of the Lab CINI AIIS

PREFAZIONE

L'Intelligenza Artificiale è un dominio di ricerca centrale per la comunità scientifica delle scienze e tecnologie dell'informazione; allo stesso tempo è una sfida capace di rivoluzionare l'intera società. Il Consorzio Inter-Universitario Nazionale per l'Informatica (CINI) ha dedicato all'Intelligenza Artificiale e ai Sistemi Intelligenti uno dei suoi Laboratori Nazionali, spesso indicato con l'acronimo inglese AIIS (Artificial Intelligence and Intelligent Systems). Al Laboratorio AIIS, diretto da Rita Cucchiara, partecipano ricercatori di tutti gli Atenei italiani e del Consiglio Nazionale delle Ricerche. A loro ho chiesto di esprimere, con l'aiuto e il sostegno di tutta la comunità informatica, una visione complessiva sulla ricerca in Intelligenza Artificiale in Italia, che potesse contribuire alle strategie di ricerca elaborate nelle sedi istituzionali.

Per rispondere alla richiesta, il Laboratorio AIIS ha messo insieme un comitato di redazione d'eccezione: persone estremamente competenti, con profili diversi ma tutte coinvolte nel progresso dell'Intelligenza Artificiale a livello globale. Esprimo qui a loro e alla Direttrice del Laboratorio AIIS i miei ringraziamenti e quelli dell'intero Consorzio per il loro impegno e per gli eccellenti risultati conseguiti. Ringrazio anche la Presidenza del Consiglio dei Ministri per il contributo dato in fase di impostazione del lavoro.

L'Intelligenza Artificiale non può essere pensata solo in un quadro solo nazionale; e oltre che della visione e delle idee del comitato di redazione CINI-AIIS il documento ha tenuto conto da subito di fonti eccellenti, tra cui le strategie sull'IA messe a punto negli anni scorsi dai Paesi europei ed extraeuropei più legati alla comunità informatica italiana da intensa collaborazione scientifica.

Le proposte iniziali sono state però soprattutto il frutto di lunghe e intense discussioni. Questo passaggio è stato fondamentale, poiché le idee migliori secondo me vengono sempre dal confronto e dalla condivisione. Partendo da una prima versione del documento, il comitato di redazione ha poi potuto raccogliere e sintetizzare le osservazioni provenienti da tutta la comunità attraverso il Consiglio Nazionale delle Ricerche e i gruppi di Informatica (GRIN) e Ingegneria Informatica (GII), che – grazie anche all'impegno dei Presidenti Paolo Atzeni (GII) e Paolo Ciancarini (GRIN) - hanno grandemente contribuito alla riflessione. Da tutti questi confronti, è emersa un'immagine dell'Intelligenza Artificiale come dominio di amplissimo respiro, declinato in molti temi specifici, che devono però essere affrontati in modo sistemico. È proprio attraverso la sinergia e la collaborazione con il lavoro in corso da parte degli organismi istituzionali, è convinzione comune, che la comunità scientifica italiana potrà contribuire con successo e determinazione a questa rivoluzione emergente.

Ernesto Damiani,
Presidente CINI

AI for Future Italy
The CINI Vision and Recommendations for Italian AI

Executive Summary

This document represents the vision of CINI —in particular of the CINI National Lab in Artificial Intelligence and Intelligent Systems (CINI-AIIS)— concerning the future of AI research in Italy. We discuss how the research in AI could affect the national ecosystem of scientific and industrial research, the technology transfer to Italian companies, the growth of high-tech startups, and the renovation of the technological infrastructure. We also suggest how collaborations between Italian research labs and institutions could be beneficial for addressing the emerging strategic and societal challenges, including the impact on the educational system from school to life-long learning.

In agreement with the European stance, we advocate a sustainable, trustworthy, and secure AI. While we share the desire of creating an AI made in Europe, we also acknowledge the need for a substantial increase in Italian research and technology expertise, both in academic and industrial contexts. Moreover, we would like to contribute to the national debate on the opportunities, threats, and risks of adopting unknown third-party AI solutions.

We analyze the national AI landscape under the lens of the CINI-AIIS Lab giving a number of recommendations to Italian Institutions for supporting research and production, and for promoting the adoption of AI technologies in order to the competitiveness of the country and the life of its citizens.

Recommendations

R#0 COORDINATION	"**National Coordination of AI in Italy"** (Comitato di Coordinamento Nazionale) with two boards based at PCM: Inter-Ministerial Coordination Board (IMCB) National AI Scientific Board (NASB) with research and industries
R#1 RESEARCH	The "**2030 National AI Research Project"**, a coordinated long-term research project composed by *Foundational AI Calls* *AI4X Calls* Where Italian researchers will collaborate to support human-centric AI-based society and AI-empowered economic development of Italian industries and start-ups.
R#2 EDUCATION	The "**Plan of attack for AI Education in Italy"**, to establish a culture of AI across all stages of people's lives: from school and university till industry with working power re-skilling and up-skilling and dissemination among citizens.
R#3 HUMAN RESOURCES	"**AI Research Talents":** An action for attracting, retaining, and growing Research Talents in AI to stop brain drain and create a new generation of AI experts to strengthen AI research, innovation and teaching.
R#4 SUPPORTING ACTIONS	"**Nurturing AI development and adoption: Support actions**": Challenges and Tech Transfer activities, support to start-ups, ethical committees, data management and sharing.
R#5 INFRASTRUCTURE	"**The National Institute of AI (INIA - Istituto Nazionale di Intelligenza Artificiale)**", structured in centers, labs and sections modeled after INFN, and supporting the implementation of the R#1-4 actions in collaboration with the existing AI research.

Table of Content

The CINI Vision and Recommendations for Italian AI

1
INTRODUCTION

This document represents the vision of CINI —in particular of the CINI National Lab in Artificial Intelligence and Intelligent Systems (CINI-AIIS)— concerning the future of AI research in Italy. We discuss how the research in AI could affect the national ecosystem of scientific and industrial research, the technology-transfer to Italian companies, the growth of high-tech startups, and the renovation of the technological infrastructure. We also suggest how collaborations between Italian research labs and institutions could be beneficial for addressing the emerging strategic and societal challenges, including the impact on the educational system from school to life-long learning.

Our main intent is to provide a brief analysis of the most prominent Italian and European initiatives in AI and present the vision of the CINI-AIIS Lab. We stress the need of a) putting research at the center, b) working together at the Italian level c) creating long-term research infrastructures and research programs that are well-coordinated at institutional level.

Starting from the initial taskforce on AI of AGID[1], several Italian institutions —including DIS-PCM (which endorsed the institution of the Lab CINI-AIIS [2]), MISE (see "Proposte per una Strategia Italiana sull'Intelligenza artificiale" [3] June 2019), MUR (PNR on AI, cyber and robotics), MID (see "Strategia per l'innovazione tecnologia e la digitalizzazione del paese 2025"[4]), Ministry of Defense[5]— have been engaged for more than two years on defining various aspects of a national AI strategy. Rather than exploring all economical and societal implications, and in accordance with the indications coming from key Italian and European documents, our proposal of "AI for Future Italy" contains just a few recommendations and ideas for long-term initiatives. These ideas are centered on research and on what we can do as a community of Italian researchers. We look at what we can do for our society and our industries, together with Italian Institutions, and how the Italian Institutions could support these initiatives.

Our hope is to promote the aggregation of all institutional AI initiatives, the definition and deployment of long-term plans for research, technology transfer, and education. We want to pinpoint the critical aspects of AI that should be protected and regulated and have a growth plan with a decade-long vision until 2030.

1 https://www.agid.gov.it/it/agenzia/stampa-e-comunicazione/focus/intelligenza-artificiale

2 https://www.sicurezzanazionale.gov.it/sisr.nsf/wp-content/uploads/2019/02/Relazione-2018.pdf

3 https://www.mise.gov.it/images/stories/documenti/Proposte-per-una-strategia-italiana-2019.pdf

4 see https://docs.italia.it/italia/mid/piano-nazionale-innovazione-2025-docs/it/stabile/index.html

5 https://www.difesa.it/Content/Documents/Documento_Programmatico_Pluriennale_(DPP)_2019_2021_digit.pdf

1.1
The CINI-AIIS Lab

The National Lab CINI[1] in Artificial Intelligence and Intelligent Systems (CINI-AIIS) has been established in June 2018, endorsed by the Department of Information for Security (DIS) of the Italian Presidency of the Council of Ministers (PCM). The aims of CINI-AIIS are:

- to strengthen Italian research in all topics of AI and Intelligent Systems, and promote Italian AI research in the world;
- to boost collaboration between Italian research in AI and Italian industry, in all sectors, specifically IT industries, SMEs and start-ups;
- to bring the benefits of AI technologies to the Italian society: for many social challenges in a wide range of areas, such as Public Administration, health, mobility, agrifood, space, cultural heritage, and national security;
- to coordinate the Italian academic and research system in AI with Italian Institutions and international initiatives.

CINI-AIIS is organized in local nodes; currently, it aggregates 55 nodes distributed in 47 Italian universities and research institutions, including Consiglio Nazionale delle Ricerche (CNR), Italian Institute of Technology (IIT) and Fondazione Bruno Kessler (FBK). More than 1090 staff persons (researchers and professors) are members of the CINI-AIIS Lab: most of them are professors or researchers with a computer engineering and computer science profile, many of whom having a multi-disciplinary background.

The CINI-AIIS Lab collected the largest survey of National Research in AI in Europe, with a description of research topics, projects, start-ups connected with each node. In Figu-

1 CINI - Consorzio Interuniversitario Nazionale in Informatica - is the Consortium of Italian Universities covering researchers in Computer Science and Engineering, under the supervision of MUR, see https://www.consorzio-cini.it/

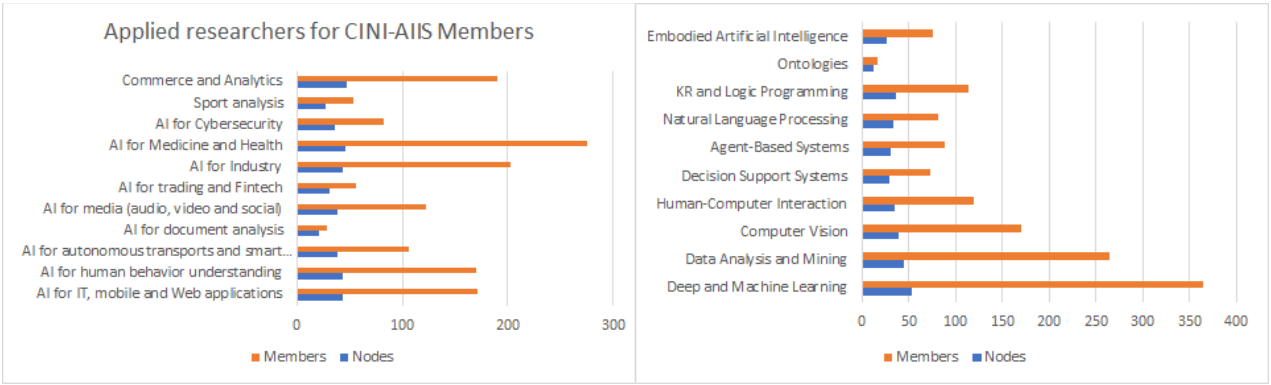

Figure 1: The distribution of research key topics among the nodes' members of the CINI-AIIS Lab (left) and the application fields of their applied research (right).

re 1 the wide set of AI topics covered by the nodes and the large plethora of application fields show the multi-faceted nature of AI research in Italy and its multi-disciplinarity.
CINI-AIIS lab promotes joint research initiatives with different CINI nodes, institutions and industries: it defines common research activities and programs at national and international level, such as the EU-MISE ECSEL program, the creation of consortia for international calls as for ICT-48 of H2020, and technological transfer in AI (including with RFI, Notartel and NVIDIA).
CINI-AIIS contributes to strategic actions on such as the Italian Strategy in AI developed by MISE, the AI National PhD Program and PNR developed by MUR.

The CINI-AIIS lab also promotes combined actions with Italian industries and startups, including the organization of the Ital-IA conferences and workshops: the 2019 Edition hosted more than 650 attendees, 400 AI projects, among which 39% with a co-authorship between industrial and academic researchers, showing a solid collaboration between production and research bodies in Italy.

1.2
Artificial Intelligence in Europe and Italy

AI technologies are at the heart of the digital transformation of our society: there is a large consensus that **AI will beget social and economic changes far more profound than any other technological revolution in human history.** Over the last decade, research in AI has made extraordinary progress in solving long-standing problems in areas such as image/video understanding, machine and robot vision (*computer vision*), text and speech comprehension and translation (*natural language processing, speech recognition*), autonomous and decision support systems; this is to a large extent due to increasingly sophisticated models of data-driven learning (*machine learning*), recently with neural network architectures (*deep learning*) from large masses of data (*big data*), combined with continuous advances in related technologies such as IoT (*Internet of Things*) with distributed sensory devices. Moreover, the step forward has been possible with the large availability of different computational resources, ranging from High Performance Computing (*HPC*), cloud-based services, mobile and embedded platforms (toward an *edge AI*).

AI is rapidly becoming an integral part of our everyday life through smartphones, wearables, personal, digital and robotic assistants, vehicles with increasing degree of autonomy, smart cities, industry 4.0. In the face of these great opportunities, there are limitations to overcome and risks to avoid or mitigate.
Depending on the course that this revolution takes, AI will either empower our ability to make more informed choices or reduce human autonomy; expand the human experience or replace it; create new forms of human activity or make existing jobs redundant; 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 so-

cieties. *We need to shape the AI revolution in a direction that is beneficial to humans, both individually and socially.*

The choices we face today are related to fundamental ethical issues about the impact of AI on society - in particular, how it affects labor, social interactions, healthcare, privacy and fairness. Moreover, transparency and security must be ensured about the source and the ownership of AI solutions, the data used for training and testing AI intelligent systems, the strategies for providing secure exploitation and for supporting maintenance and future upgrade of such systems. This state of affairs called for an European Vision of AI, that has been defined by the European initiatives and related documents, starting from the first programmatic Document "Europe AI" of April 2018[1] and further developed by the High Level Expert group on AI[2].

The objective to be pursued, coherently with the EU Vision, as well as OECD's[3], is *Trustworthy and Sustainable AI*, aimed at the benefit of humans at both individual and social level, through AI systems that incorporate European ethical values and ensure respect for human rights and democratic values. The European vision focuses on Human-Centered AI and aims at making Europe the global role-model for responsible AI[4]. This is a frontier on which Europe and Italy can excel, in the awareness of the many challenges that are still open.

1 https://publications.jrc.ec.europa.eu/repository/bitstream/JRC113826/ai-flagship-report-online.pdf

2 https://ec.europa.eu/digital-single-market/en/news/ethics-guidelines-trustworthy-ai

3 The OECD. http://www.oecd.org/going-digital/ai/principles/

4 http://ec.europa.eu/newsroom/dae/document.cfm?doc_id=51625

1.2.1
AI European plans of action

In the last five years, many countries all over the world have been discussing how to shape processes and laws for AI, funding for research and technology, and training programs to make sure the workforce is ready for the revolution brought about by AI. The European Union has started a few specifically AI-oriented initiatives. The European Strategy for Artificial Intelligence was launched in April 2018, backed by EUR 1.5 billion in funding and encouraging EU countries to develop their national AI strategies by mid-2019, these strategies were expected to outline investment levels and implementation measures. The overall and shared goals include boosting the EU's scientific base, technological know-how and industrial capacity; preparing for socio-economic changes triggered by AI; and ensuring that the technology has an appropriate ethical and legal framework. The ICT-48 call of H2020 was aimed at creating a "vibrant European network of AI excellence centres" with the objective to foster cooperation among the best research teams in Europe, joining forces to tackle more efficiently major scientific and technological challenges in AI, hampering deployment of AI-based solutions. After 2020, the Multiannual Financial Framework for 2021-2027, Horizon Europe, will be key for the development of the technology and EUR 2.5 billion will be allocated to AI. In the next Horizon Europe, as well, a key strategic orientation of the Cluster "Digital, industry and Space" has a central statement in "trustworthy AI".

Here we briefly report on the national strategies defined by some EU countries. They have in common: i) alignment with the Sustainable Development Goals settled by UN's Agenda 2030[1], ii) the construction of a shared ethical model for the development of AI systems, iii) principles that cover trust, scientific evidence, fairness, transparency and robustness, iv) a multidisciplinary viewpoint, v) efforts for making data available and usable.

France AI Strategy

France AI strategy[2] is articulated along three axes: i) Foster talents, ii) Spread AI in economy and administration, iii) Ethics. The overall investment (1,5 billion of Euros in 4 years) is divided among research & education (45%), industry, innovation & defence (45%), and public administration (10%). In January 2019, 4 hubs were selected with the idea to enhance and strengthen the best ecosystems that already have areas of excellence and experiences of inter-disciplinary and industrial collaboration, rather than starting new realities from scratch. The 4 Interdisciplinary Institutes for Artificial Intelligence – 3IA coordinated by Inria and supported with 300M Euro (with sinergic effort of central government, regional government and industry) are:

- MIAI@Grenoble-Alpes focusing on health, environment and energy.
- 3IA Côte d'Azur, in Nice, looking at health and development of territories.
- PRAIRIE, in Paris, concentrating on health, transport and environment.
- ANITI, in Toulouse, covering issues related to transport, environment and health.

This action is accompanied by an exceptional effort in strengthening acquisition and retention of AI talents with 190 new AI research chairs and 500 PhDs in AI per year.

1 https://www.un.org/sustainabledevelopment/development-agenda/

2 https://www.gouvernement.fr/en/ai-research-institutes-established-in-grenoble-nice-paris-and-toulouse

Germany AI Strategy

Germany AI strategy[3], announced in 2018, is based on an investment plan of 3 Billion Euros to enhance the country's AI capabilities over the next six years. Private sector companies are poised to catch up with that number, bringing the total investment to 6 Billion Euros. The German strategy encompasses plans to build 12 AI Research & Development centers (expanding the existing ones and creating a few new ones) and launch 100 university chairs and a programme to support junior researchers focused on augmenting AI capabilities and reinforcing academic teaching in the field of AI. The goal is to establish "*AI made in Germany*" as an international trademark for cutting-edge, secure AI applications aimed at serving the common good in line with Europe's core values. Other priorities settled by the German strategy include: develop and use AI responsibly; promote dialogue throughout society sector; develop a Franco-German research and innovation network ("virtual centre"); anticipate and mitigate the impact of AI on labour; make data available and usable.

Analogous approaches can be found in the Finnish Center for AI (FCAI), and in the Alan Turing Institute (ATI) in the UK, a distributed laboratory of the best UK data science and AI centres, with a lightweight central office at the British Library. UK Alan Turing Institute is the recipient of structural funds from UK Government and is financed by several member universities; the funding is managed by proposing calls and specific projects co-funded by industries and by selecting fellowships, for individual grants, similarly to France's "AI chairs" initiatives. ATI is also a research center which collects researchers and software engineers for prototyping AI solutions internally.

Recently, Spain has also published its AI strategy, setting priorities for 2021-2028, aimed at mobilizing the synergies between the different levels of public administration and supporting the co-development by the public and private sectors, in specific strategic areas. Worth noticing is a strong plan for postdoc positions aimed at making postdoc salaries more competitive and at providing funds for future permanent positions of early stage researchers.

3 https://www.plattform-lernende-systeme.de/ai-strategies.html

1.2.2
AI National Landscape

Artificial Intelligence is recognized as a crucial enabling technology in Italy, so that Italian institutions started very early to define programmatic documents. The first document addressing the impact of AI was by AGID in 2017, which created an AI Task Force and a document on "AI Task Force for Citizen[1]" focusing on AI for PA. This activity has been prodromic to a national coordination of research units, which lead to the creation of the CINI-AIIS Lab in 2018, under the endorsement of DIS-PCM.

Currently, the national AI research strategy has been addressed in the MUR initiatives; in particular in the 2019 PNR[2] document. The new initiative for the PNR 2021-2027 considers "Artificial Intelligence" as one of the central topics in the context of "Informatica, Industria e Spazio", in analogy with the parallel EU initiative.

A first concrete step was taken in December 2019 with the approval of the plan by MUR to support, jointly with CNR, a national doctorate in AI[3], which will train 200 PhD students in AI to boost research and industrial and social innovation in the country. The AI national doctorate aims at bringing the training and research of doctoral students closer to the needs of the country and its social and industrial structure; specifically, the doctoral program targets both the foundational aspects of AI and the development of AI technologies in strategic sectors for the country, by aggregating the necessary multi-disciplinary skills. The selected thematic areas are: AI for Health and Science of Life, AI for Industry, AI for Security, AI for Environment and Agriculture, AI for Society.

Recommendations for an Italian AI strategy are addressed in the report of MISE[4] and in its preparatory actions, pointing out the need of collaboration between research bodies and industry to promote innovation and to address societal challenges. The aim is to strengthen AI production for italian industries and the AI adoption for the digital economy. The document proposes actions for what has been called a "new Italian RenAIssance" (centered on responsible AI technologies and "AI for Goods") in the direction of the United Nation Agenda 2030[5]: it suggests to promote the collaboration between existing research labs and centers, the CINI-AIIS Lab, the current research and innovation bodies such as the Competence Centers and the Digital Innovation Hubs, established by MISE in the Industry 4.0 framework. Additional recommendations are devised for a national data strategy, for empowering AI education and for a inter-ministerial coordination at national and European Level. Similar recommendations have been recently included in the previously cited "Innovation Action 2025" of the Digitalization Agenda of the Italian MID (Ministry of Technology Innovation and DIgitalization), where several items focus on AI for the public administration and the Italian Society Renaissance.

Besides the risks associated with the misuse of AI in so-

1 https://ia.italia.it/assets/librobianco.pdf

2 MUR: PNR working group on Cyber, AI e Robotica 2019

3 "Proposta di un Dottorato Nazionale in "Artificial Intelligence" MUR, 2019

4 https://www.mise.gov.it/images/stories/documenti/Proposte-per-una-strategia-italiana-2019.pdf

5 ONU AGENDA 2030

cietal context, the risks of AI are related with possible dual-uses and with the protection of national technological AI assets. AI is recognized as the most strategic Information Technology in the Defence Environment. CINI-Lab AIIS has been endorsed by PCM-DIS[6] to protect the Italian AI infrastructure in the national cyber-security perimeter, and collaborates with the Italian Institutions to ensure that potential risks associated with AI technology are properly addressed.

Artificial Intelligence is a large multi-faceted technology that cannot live alone, but it is enabled and empowered by other important Information Technologies, such as IoT (distributed embedded devices and sensors), computing infrastructures (cloud, HPC), new communication protocols (5G), new IT paradigms such as blockchain and future solutions, such as quantum computing. Several initiatives at European and national level are already ongoing in these fields and strong coordination actions need to be pursued to connect technologies and amplify their impact.

AI needs high computational power. CINECA maintains the largest supercomputer facility in Italy, one of the largest in Europe (see the Marconi in the top500.org list) and has been funded by EU together with Spain and Finland for the next supercomputers in the pre-exascale HPC call; computing resources are already available to support AI research under a European umbrella such as PRACE, providing GPU resources such as the new Marconi100 HPC and two DGX servers devoted to machine learning research. These GPU infrastructures are available for AI projects to Italian researchers, thanks to an agreement with CINI. However, a key enabler for the development of AI strategies in Italy is the pre-exascale HPC Leonardo supercomputer, funded with 120M€ from EU and 120M€ from Italian institutions. In the next years, the availability of Leonardo supercomputer will be a major asset for Italy in AI activities, especially in deep learning, computer vision and NLP, data storage and analytics for both public institutions and private industries.
Other important contributes to the AI landscape are provided by a variety of open science platforms supporting FAIR (findable, accessible, interoperable, reproducible) sharing of data and algorithms such as SoBigData[7] offering access to datasets algorithms and services on SocialMining and Big Data Analytics the European Language Grid[8] platform for speech and NLP resources, tools and services; the platform AI4EU[9] currently under development by the corresponding EU project aimed at integrating and making accessible the AI resources produced in Europe.

6 PCM-DIS Report of Policies of Information for Security" PCM 2018 (see note 2)

7 www.sobigdata.eu coordinated by CNR

8 https://www.european-language-grid.eu/

9 https://www.ai4eu.eu/

1.2.3
AI research in Italy

The Italian AI strategy can rely upon a strong and qualified basis of scientific research. Among the strengths of Italy in the AI sector we certainly find the quality of scientific research. Considering the data from Scimago, in the period between 1996-2018 Italy is ranked #8 in Europe for Documents (i.e. number of papers) related with AI and ranked #6 for citations during 2018. If we consider the data from Scimago regarding only the western Europe, in 2018 Italy is fourth for number of documents (after Uk, Germany and France), but is second only after UK for citation number (before Spain, Germany, France and Switzerland). Considering the Brexit we could say that we have the first position in the EU community for citations.

The Italian research community in AI shows international excellence in key areas such as machine learning, natural language processing, computer vision, knowledge representation and reasoning, intelligent robotics, trustworthy AI, mobile agents, high performance algorithms. This is demonstrated not only by the number of papers attesting scientific results, but also on the number of EU projects where Italy has a central role. The CINI-AIIS[1] survey counts more than twenty H2020 EU projects active in 2018-2020 and 10 EU ERC grants on AI topics.
Italy is in the board of Direction of EurAI, in the board of International Computer Vision Foundation and ECVA, in the board of IAPR and ACM SIGMM and SIG CHI that are special groups of ACM where AI is becoming central. The major AI international conference, IJCAI with thousands of attendees, will be in Bologna in 2022. Other important international conferences regarding AI topics have been and will be organized in italy with thousands of attendees: example are ICCV in Venice 2017, ACL in Florence 2019, ICPR In Milano 2020, the WCCI in Padova 2022. Italy is active in EU associations and initiatives with a central node of CLAIRE in Rome and with more than 10 ELLIS Fellows. All these initiatives, together with summer schools, workshops, conferences and academies promoted by Italian scientific associations such as AIxIA, CVPRI, SIREN, GULP, AICL, IEEE-CI and many others, are now in mutual contact and shared within the CINI lab AIIS.

The Italian research community attracts investments from international companies. Very recently NVIDIA signed an agreement with CINI to promote the initiative “AI Nation” with Italy, createnging different NVAITC (NVIDIA AI Technology Center) to empower research in deep learning and HPC, also in conjunction with the HPC CINECA resources. This testifies the excellence of Italian Research and the value of Italian talents in AI. Surely, the presence of big international IT companies could help in limiting the AI young brain drain, keeping our talents in country and also becoming an attractive destination. (See also the proposed action to promote PhD personnel in companies within #R4.)
The Italian community of the CINI Lab AIIS is becoming active at the EU level too. The CINI Lab AIIS participates in three out of four projects of the Center of Excellence in AI of the ICT-48 call. Namely, the recently approved HumanE-AI-Net, ELLIS and TAILOR, focusing on foundational research, machine learning and human-centered AI.

Italy is active in applied research in AI with many projects

1 CINI Lab AIIS : Research Survey 2019

co-funded by Italian institutions (such as PON projects with MUR and ECSEL projects partially funded by MISE) and by Regional FESR funds. The CINI Survey , that is only a partial picture of the activity in “AI for X” projects counted more than 600 different projects, and more than 270 active in 2020. Among them 15% has been funded by industries, 35% from EU and international boards and the remaining 50% from local, regional and national funds.

AI4X AI and the applications

AI is a pervasive field. The CINI Lab AIIS is very active in the application of scientific results to a wide range of industrial sectors, while keeping also societal challenges into consideration. Among the applications in “Ai for X” (AI4X from now) the AI CINI community is very active in projects for Medicine and Health, for data analytics and for social commerce and media data. See Figure 2. AI is applied considerably for human behaviour understanding, such as for sport analysis and for human security in smart city, often connected with intelligent transportation. AI for Cybersecurity is very important and has a critical impact. AI for commercial and Fintech is a growing area that is becoming active worldwide, where research achieved important practical results. Last but not least AI is very often applied in Industry for all industry 4.0 digitalization programs. AI Centers in Italy collaborate with the Industry 4.0 Competence Centers,
Digital Innovation Hubs and with local industrial districts (in automotive, textile and fashion, mechanics and robotics, transportation and logistics, space industry etc) .
Despite the growth of initiatives in research and applied research, Italian research in AI suffers from problems of system scale, critical mass of research laboratories, limited inter-disciplinary integration, slow technology transfer and adoption of AI by companies, haemorrhage of talents attracted by Ph.Ds and research laboratories abroad[2] (Again see specific action for hiring PhD personnel in companies within #R4.). In order to leverage and exploit these assets and keep pace with other countries (United States, China and European partners) a substantial investment in our higher education system, attracting the best researchers is urgent.

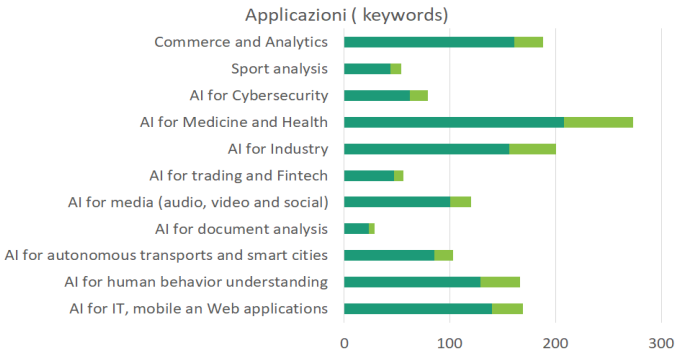

Figure 2 The distribution of research application keywords in the projects among the nodes’ members of the CINI-AIIS Lab.

2 Italy’s Roadmap towards the European Research Area Objectives, indicators and targets. MUR

1.2.4

AI in Italian startups

Assessing the status of the Italian industry in the adoption and production of AI solutions is out of the scope of the document. Here we would like to point out the status of the start-up in AI , that very often start from the research labs in academia or in the national research centers, are created by ex-phd students and are very connected with research. Although the scenario of IT startup in Italy is changing, the number of new innovative startups is increasing and Italian Institutions are supporting them considerably (see recent actions of MIR), the situation should be improved, especially in AI. The Italian scenario of AI start-ups and adoption of AI solutions is behind other EU countries. In a recent report (RolandBerger report[1]) by France Digital Agency, the current state of affairs is observed from the point of view of critical mass of start-ups, research labs, and AI adopted solutions. Three different clusters of EU countries emerge from the analysis: leaders (France, UK, Germany and Spain), rising stars (Ireland, all nordic countries, Netherland, Slovenia and Switzerland) and followers (all the others including Italy, Portugal, Greece).

The report addresses also the presence of AI themes in the scientific and public debate, trying to measure the number of public events on AI (meetups) in the last 10 years, using data from Twitter and Linked-in. In Italy the public discussion on AI in 2019 has been rather limited: about 600 meetups versus 7000 in UK. While the outcomes of the cited analyses may need further assessment, urgent attention is needed to address the delay of Italy in focussing on AI, as a ground breaking technology with significant impact on our society an economy.

The nodes of CINI-AIIS are working with startups: in the CINI Survey we collected data on over 90 startups and university spin-off where the member of CINI-AIIS are connected with, focussing on AI solutions. Italy needs to support better the industrial research with these new companies, connected with the local landscape to answer the requests of other Italian industries and also open to export italian technologies in the worldwide market.

1 https://www.rolandberger.com/fr/Publications/Joining-the-dots-A-map-of-Europe's-AI-ecosystem.html

2 The CINI-AIIS Vision of AI

As most of the countries in the world, Italy needs to focus on a long-term national strategy in AI. Building on the work already done in Europe and in the Italian institutional initiatives, discussed above, we propose a CINI-AIIS vision of the AI development in Italy. Our vision can be summarized in three key points:

Working together

Research first

Structured (long term) investments

To achieve this vision, CINI-AIIS is ready to play the role of an interface between the AI research community, the institutions, the industry and the society.

2.1

Working together: “Researchers, Institutions, Industries: a big deal”

AI is more than a broad promising scientific discipline; it has been recognized as the engine of the future economic development and a possible direction for finding solutions to many social challenges. At the same time, AI solutions, services and systems have started to be effective in the last few years only. Italy must mobilize a critical mass of resources through a synergistic cooperation among all actors, in a structured way. Specifically, cooperation should involve:

- first, the government, which should play a key role in the coordination, including all Italian Institutions, such as MUR, MISE, Ministry of Innovation, and other Ministries involved in any application area of AI;
- second, the AI research community, which is very interdisciplinary and spread throughout the country, and which should be coordinated through a single, reputable entity, i.e. CINI-AIIS;
- the even larger and multi-disciplinary world of education, both for improving vertical competences in AI, and in many supporting actions where mutual knowledge is needed (e.g. working on legal aspects of AI, or for AI on medicine);
- the industry , with a strict connection with industrial associations and some open channel of cooperation between industry and research such as the Competence Centres and the digital Innovation Hubs.
- finally, the society, which would need to make people aware of the risks and benefits of AI for all the citizens.

Coordination is particularly important to deal with the critical and potentially dangerous aspects of AI. Italy must promote research guided by our values of human rights and societal fairness. The Italian Institutions working on Cyber-security, Defense and Privacy should be fully aware and contribute to those AI technologies that could affect the societal life considerably (e.g. face recognition or human behaviour understanding, or web data understanding, construction data for disaster prevention as well as fake news creation, autonomous vehicles/machines), but, at the same time, Institutions and research should work together on defining a special *“perimeter of protection for Italian AI”* coordinated by Italian Institutions. Italy should therefore identify which AI technologies fall into the “perimeter of Security” for critical industries and institution.

2.2
Research first. “Italian AI Research is not an option”

AI results are still in their infancy and Italy must contribute in the development of the AI products we will have in 2030 and must foresee the impact they will have in the Italian society in 2050, that is, the world we will hand out to the children born today.

The AI products and the society for tomorrow are necessarily based on the research of today. Italy deserves to be one of the big players in the game of international AI research. We start from an excellent basis, but the competitors are growing fast due to enormous investments carried on by some nations such as China, HUE and USA. Also Europe is going in this direction. Italy too must invest in structured research in this field.

Italian research should have a leading role in the next generation of AI, which will produce machine learning systems, systems that reason and act autonomously, predictive analytics engines, diagnostic services, social robots etc. In order to build this new generation of systems, Italian AI research should build on foundational fields and the growing multi-disciplinary AI. Machine Learning, Computer Vision, Natural Language Processing and Robotics must work on Italian visual and textual data, that represent our knowledge (e.g. Italian documents and cultural heritage images). For example, data analytics for real-time industrial process monitoring, and perspective analytics and automation in industry should be thought, designed and developed in Italy and for the Italian context.

Importantly, we believe that regulations should be defined for supporting researchers to create a new generation of AI, respectful of rights and with limited risks by design. The awareness of the risks, with the increase of the attack surface in the cyberspace, the dangerous effects of possible dual use, or, more simply, ignorance about the adoption and lack of transparency of AI, should be considered also a research topic, to support awareness in the adoption of AI technologies in industries and in the society.

Therefore, we call for a long-term finalized research plan, that could involve all Italian sites on all topics of AI research, that could build upon the success of the “Progetto Finalizzato Sistemi Informatici” that, in the 1980s and 90s, created the basis for today’s Italian University excellence. Our vision of “*Italian AI research is not an option*” is based on competitive projects, to be selected and evaluated very carefully, although coordinated in a single framework, inclusive and large enough to have an impact in a 2030 perspective for the world of 2050. Results of public funded projects in terms of publications, disseminating actions, education feedback, patents, prototypes, start-ups and technology transfer should be used as criteria for evaluating the results in a long-term view, including in Italian programs, as VQR.

To empower research, not only should Italy establish a big *National research projects in AI*, but also invest in personnel, and, ultimately, plan the creation of a *National Institute for AI*.

2.3

Structured long-term investments: “There is no free-lunch Italian AI”

The Vision of AI for Future Italy requires a substantial effort to bring the foreseen change and growth in the Italian society. Therefore, Italy needs to plan an investment program based on both public and private funds, possibly complemented by some fund-raising initiatives, such as an “AI-Telethon” for the Italian research in AI, and tax benefits for investments in AI. We propose four main areas for an investment that matches and fulfills the expectations raised by the future vision of AI.

As mentioned in the previous section, the first boost to Italian research should be given by funding research activities in Italy. Such research plan should address both foundational and applied research, and support a strong coordination of AI researchers in Italy.

Human resources are the second building block of the investment plan. A new generation of AI researchers needs to be created building on the already established National Doctorate in AI. Ph.Ds from our education system should have an attractive career path to remain in the Italian research system and support the growth of Italian industry.

A third pillar of the investment plan should address all the actions that support the transfer of the research outputs towards industrial solutions. In addition to the current practices, we call for the establishment of industrial challenges (as in DARPA and IARPA) that address Italian priorities. Considering the recent proposals of MID that suggested the “right of innovation”, thus the right for the Italian ecosystem to do experimentation for innovating, we would extend it with the “right to research” in AI on critical data, such as personal information of health, defence and security data.

A fourth major investment that will support the development of AI in a longer term perspective is the creation of a National Institute for AI, following the approach taken for analogous strategic initiatives, such as INFN. *The National Institute for AI* should create a strong coordination for the development of AI in Italy and, in short, provide a stable basis for the realization of the AI for Future Italy vision.

2.4
Evaluating results of AI policies

The results of a "AI for Future Italy" programs should be evaluated by several KPIs, exploring the impact in some directions:

KPI #1

Research excellence

"*AI research excellence in Future Italy*" will be the first measurable result to strengthen the Excellence of Italian Research in Artificial Intelligence and Intelligent Systems, keeping and improving the Italian ranking in the world, supporting the central role of Italy in European AI initiatives and in international communities, achieving a critical mass for AI research in universities and research institutions, also by favouring attraction, retention and recovery of talents in AI. All these parameters can be and should be measured in terms of publications, bibliographic indexes, funded projects, prizes etc. Adopting an Anglo-saxon terminology, we could say we must measure the "produced value" of research, during and at the end of each project and research initiative. In this sense, also the evaluation procedures currently adopted in Italy should change according with international trends (e.g., for AI, by evaluating the results published in the most important international conferences and not only in journals, considering international ranks of publication venues).

KPI #2

Coordination between Foundational and Applied Research & Innovation

"*AI in Future Italy*" will build a strong coordination and interaction between foundational and applied research. Results will be evaluated in terms of achievements that bridge some existing gaps between academic research and technology transfer towards industrialization, as well as some gaps in public digitalization and PA changes. Hence, a well-balanced mix of foundational research, that can support and increase the current outcomes of AI research, must be combined with vertical actions that bring the value of research to national development. In order to shape the domains of intervention, the model based on the axes **AI for industry, society and sustainability**, presented in MISE's documents seems particularly well thought, and is summarized below:

- **Industry**: "*support a stronger Italian Industry empowered by AI"* to improve Italian competitiveness in typical made-in-Italy industry, in line with Industry 4.0 (from manufacturing to pharma), by fostering the adoption of AI technologies and the co-design of new AI solutions; by performing technological transfer and disseminating the AI expertise in and across industries; by leveraging the outreach of Italian IT industries, specifically, start-ups and SMEs, and including service providers such as fintech, document and media analysis, cultural and creative industries, etc.
- **Society**: "*answering Italian societal challenges through AI solutions*", exploiting cutting-edge AI solutions, coming from academia (also leveraging the project experiences of CINI-AIIS's nodes) to work in services for the society, such as Health and Medicine, Public Administration (PA), Security, Cultural Heritage, and so on. In order to gain acceptance and maintain diversity, a real-life, multi-stakeholders approach would be needed.
- **Sustainability**: "*making AI the kernel for a new sustainable economy in a sustainable environment",* working with institutions and industrial stakeholders for core sustainability issues such as energy, transportation, agrifood, climate changes, environmental monitoring, earth observation, etc.

With respect to recent experiences, future Italian Projects should be shaped differentlyl. Too large projects, proved to be too dispersive (often too many different actors) to be concrete. A possibly new approach could be a single National AI program with some coordinated and non overlapping projects, composed by several research units and a single or very few external industrial consortia to concentrate the effort and the knowledge of many researchers into a single focused topic with tangible results. Topics should be defined by the funding institutions, as in DARPA, with challenges or specific requests (e.g. a specific health issue and, or a key industrial problem) and results shared at the end by many stakeholders. In applied research projects involving industries, tangible results should be verified also in terms of concrete industrialization and market-place strategy, in a full made-in-Italy pipeline. Moreover, industries should hire and keep the Phd students trained in these focused applied research projects, with an adequate salary.

KPI #3
Support the growth of AI in Italy at all levels

"*AI in Future Italy*" will address the introduction of AI in the Italian society at large. First of all, Italy should direct its efforts towards human-AI, with an integrated approach to social and ethical values. This would require not only dedicated interdisciplinary research actions, but also initiatives that address the potential risks as well as the design of appropriate measures to keep them at a level that can be uncontroversially accepted in our society. This KPI comprehends the measure of the *success of new initiatives in education,* measured in terms of students, results and their successful inclusion in the job market. The education initiatives should not be restricted to the high level education system, which nonetheless will require appropriate actions, but to the whole school system that should be innovated by creating a stronger link between the academic system and the earlier levels of the education system forecasting a strict research cooperation between AI experts and pedagogists.

Moreover, the widespread adoption of AI approaches in services and production calls for both an education program for the existing workforce, that effectively supports co-working models rather than plain automation, and academic curricula with core AI topics as well as interdisciplinary topics at the intersection of AI and specific domains, while also addressing challenges such as life-long learning, reskilling and upskilling AI competences in the industry, etc. Results on education in AI will be normalized w.r.t. the number of professors and researchers available in AI in Italian Academia, that are now under the threshold of acceptance and must be supported with specific actions.

3 Recommendations for Actions

Based upon the analysis of the context sketched in the previous section, below we formulate key recommendations for actions to be taken in order to achieve the goal of enabling Italy to play a leading role in AI. research community, the institutions, the industry and the society.

R#0
National Coordination of AI in Italy

As indisputably outlined by all the strategies developed worldwide and nationwide, AI is impacting all sectors of our society and economy. Therefore, an effective strategy in AI would imply *a strong coordination and cooperation among all the actors*, from institutions and funding agencies to research bodies and stakeholders.

Recommendation #0: Define a "National Coordination Center" which - due to the horizontal and strategic nature of AI - should be *managed by the Presidency of the Council of Ministers (PCM),* which can have the required 360-degree vision of the actors to be involved in each specific strategic decision.

This is very urgent and strategic for Italy, in order to better exploit all resources that can play a role for the AI strategy (research and innovation manpower, computational infrastructures, research labs in academia and industries, funding resources). Moreover, it should avoid any duplication in control and management, leaving to each institution its specific role: e.g. the priorities in "AI for Medicine" should be devised by the Ministry for Health, those for "AI for Mobility" by MIT, and the "AI research initiatives" by MUR, under a single coordination. Industry should be represented, coordinated by MISE.

As has also been suggested in the MISE Strategy AI Recommendation and in line with other EU Initiatives such as ERA[1], Italian AI calls for a *single control room* ("cabina di regia") for the management of initiatives, the definition of policies and priorities of the country, the exploitation of opportunities for synergies without dispersion of resources. This must also have a legislative and regulatory role, be in contact with other decisional poles for critical AI-related factors (such as data processing, privacy, cybersecurity), be in easy contact with European and international institutions and for extra-national strategies. Coordination must be streamlined and efficient and must be able to respond to the AI challenges promptly.

The coordination center at PCM should manage:

- an *Inter-ministerial Coordination Board (IMCB),* as suggested for example in the Italian Response to ERA, with a stable board including reference persons of each involved institution (MUR, MISE, Innovation Ministry and all other Ministries where AI could bring strong impact);
- A *National AI Scientific Board* (NASB), including CINI-AIIS which can represent research in AI, CRUI for representing other related and affine competences and other stakeholders (e.g., industrial associations), endorsed by PCM, as already successfully experienced in Cybersecurity (National Coordination Committee in Cybersecurity).

The main roles of the National Coordination Center in AI should be the following:

- having a real-time picture of AI needs, opportunities and risks at Italian level and ensure a fast, reactive and proactive action;
- providing a stable contact for any AI initiatives in Europe and worldwide;
- establishing a fruitful cooperation with other research and institutional agencies such as ASI and ESA for space, AGID for PA digitalization, etc.;
- providing policies and concrete actions for the imple-

1 https://ec.europa.eu/info/sites/info/files/research_and_innovation/knowledge_publications_tools_and_data/documents/ec_rtd_factsheet-era_2019.pdf

mentation of the National research in AI plan (see R#2), the Educational initiatives (see R#3), the National AI Supporting actions (see R#4) and for the definition of a stable infrastructure of AI Research (see R#5).

All the national strategies foresee the development of research in AI, by committing to two main kinds of resources: human resources and research funding. Below we articulate our viewpoint on how these resources could be targeted.

R#1
The 2030 National AI Research Project

The basic action to strengthen research in AI at the National Level is a dedicated funding articulated in a *single structured long-term framework*. The rationale for a unified project framework has its national roots in the *Progetto Finalizzato* framework, and specifically in the *Progetto Finalizzato Sistemi Informatici e Calcolo Parallelo*[1] back in the 1990s.

This long-term coordinated research project had a substantial impact in strengthening and broadening national research in computer science in subsequent years. Moreover, it was very successful in creating networks of young researchers that shaped the development of the field over the next two decades.

Recommendation #1: Establish a "2030 National AI Project"
Establish an Italian flagship research project in AI, articulated into a wide and comprehensive horizontal layer of foundational research, whose outcomes can be successfully applied to create novel vertical solutions in applicative fields.

As a result, the National AI Project should be organized in two intertwined parts:

Foundational AI Projects
in thematic areas including Knowledge and Reasoning, Machine Learning, Computer Vision, Natural Language Processing, Human-Computer Interaction, Trustworthy, Ethical and Legal AI, Data Science, Robotics and IOT. Research should look into the future, attacking open challenges in these area and in other emerging ones. Joint research is needed to answer big questions as:

- **Trustworthiness**: How to learn fair AI models, even in spite of biased data? How to develop explainable and interpretable AI decision processes? How to develop transparent AI systems for increasing user trust? Trustworthy AI should also be "secure by design": How to design secure AI system, that are resilient to adversarial attacks?; vulnerability against adversarial attacks is an example.
- **Learning and reasoning**: How to integrate AI paradigms and representations for reasoning and learning in order to support trustworthy AI? How to define new robust, sustainable, and generalizable approaches of

1 B. Fadini (a Cura di) "Sistemi informatici e calcolo parallelo. Progetto finalizzato CNR: risultati, stato delle ricerche e prospettive" Franco Angeli 1991

machine learning covering new emerging paradigms (e.g. generative and reinforcement based, with or without supervision, with or without big data, multi-task learning, memory and attention based approaches)? How visual, language and other sensing data can be processed in order to create intelligent perception systems? How to Integrate new approaches to learning, reasoning should allow AI systems to bridge the gap between perception and reasoning, in order to combine knowledge-based and data-driven methods, to explain their behaviour and allow for introspection of the resulting models? How to include new form of reasoning such as causal inference, meta learning, continual learning, learning by few data, automated model selection? How can these models be sustainable from the computation point of view, considering also energy consumption? How can they be integrated in edge-AI systems for mission critical contexts (industry, space, defence...).

- **Deciding and Learning How to Act.** How to empower an AI system with the ability of deliberating how to act in the world, reasoning on the effects of its actions, learning from past experiences, as well as monitoring the actual or simulated outcome of its actions, learning from possibly unexpected outcomes, and again reasoning and learning how to deal with such new outcome? How to combine learning, planning and reasoning with action in embodied-AI systems? How intelligent and autonomous systems can interact with humans and with the world? New paradigms of deep monitoring working machines, and collaborative and interactive human-AI-robots loops should be considered.
- **Reasoning and Learning in Social Contexts.** Agents should not reason, learn and act in isolation. They will need to do it with others and among others. How AI systems should communicate, collaborate, negotiate and reach agreements with other AI and (eventually) human agents within a multi-agent system? Agents that take the social level into account would be a key element for building multi-level, AI-based generative simulation models of social behavior, sorely needed for policy support.

AI4X Projects in specialized domains, following the structure suggested in the MISE strategy for AI, and presented in section 1.3; namely:

- ***Industry***: AI has a direct impact in all industrial contexts, and especially in the ones characterizing Italian assets: *Manufacturing, Robotics, Automotive, Space, Pharma, Retail, but also Textile, Fashion and Food industry*; besides, AI constitutes a key enabler to foster industrial sustainability through the integrated optimization of production processes and energy and resources consumption (e.g, demand response, flexible consumption patterns, etc.)
- ***Services for society***: previously cited AI topics, as well as the object of future research, provide already usable results, in term of research prototypes that can be tested and adopted in most of the Italian challenges, for services in *Security, Health, Well-being, Public Administration, Finance, Culture, Tourism*, *Education*;
- ***Sustainable Economy***: AI services and systems are directly applicable for their optimization and predictive capabilities in topics related with Environment, Energy, Transportation, Agriculture, Climate Change, Sea monitoring, etc..

The projects should be selected through a competitive process, possibly combined with a negotiation phase. The proposers should be selected according to their effective experience, the capacity to provide future long-term research in AI, but also to have existing experience at an adequate TRL, to be useful in the short term. Multi-disciplinary teams should be supported. The projects should be coordinated, in order to find synergies, avoid duplications, exploit common results in different contexts, and multiply their impact.

The *National AI research flagship* should have a long duration, possibly a decade towards 2030 with projects of at least four years, in order to allow the exploitation of funding resources in creating of new phd and post-doc positions (as RTD-A); they could have different phases; for instance, the projects providing measurable results could be refunded, after periodic benchmarking, in order to deal with the 2030 vision.

While *Foundational AI Projects* aim at leveraging the research assets in AI, the *AI4X Projects* are expected to have a significant industrial involvement, which is a key element to favour technology transfer in application domains. The composition of the consortia should therefore include all stakeholders from research, industry and end users. The priorities on the applications areas of the AI4X projects will be defined by the coordinated institutions co-funding the research, together with the stakeholders.

All projects will be evaluated according with previous KPIs, and thus in terms of both scientific publications and applicative impact. They are expected to produce results (and therefore be evaluated) also in terms of data and methods made available both for the development of scientific research and for dissemination and deployment in Italian industry. A common framework for collecting, generating, managing and protecting these resources, available at a national level, is addressed by a specific support action described below.

We expect that the outcomes of the projects will have a great impact on the Italian society and economy, fostering PA and industry digitalization, supporting industry 4.0 actions in the adoption of new technologies, creating new AI made-in-italy products and innovative AI-based processes. The project will be designed by MUR, according with current initiatives such as PNR missions and AI National Doctorate, coordinated with tech-transfer activities promoted by MISE, the innovation recommendations of MID and coordinated by the inter-ministerial board described in R#0.

The Projects should also cover **ethical and gender bias** issues, that are becoming central in the AI foundational and applied research.

The action of a long term research project, competitive, based on measurable excellence in AI and inclusive of all existing Italian capabilities in a multi-disciplinary framework will be an Italian brand. We want to coordinate Italian Research that we know, after the CINI-AIIS recent initiatives of research and tech transfer, has a very large potential, in many cases not exploited yet. We believe that only a coordinated flagship project with several integrated sub-projects, collaborative and integrated by-design and finalized to common measurable results will be the italian answer to many European research Initiatives.

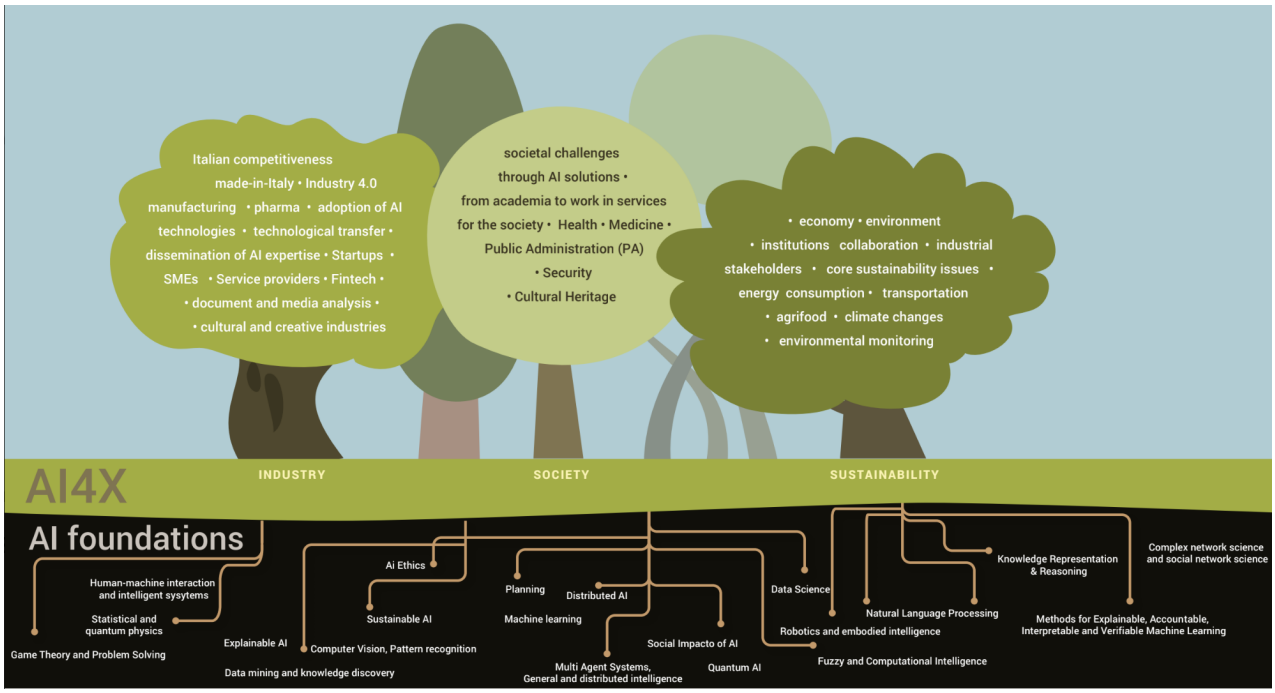

Figure 3. The 2030 National AI Research project for Future Italy

R#2

The Plan of attack for AI Education in Italy

To establish a culture of AI along the lines of the famous quote "*intellectual growth should commence at birth and cease only at death*" (Albert Einstein), we envisage AI as a pervasive area which needs to be addressed since the very first steps of scholar education till higher education and life-long learning. AI should be a crucial support for innovative teaching activities. Guaranteeing a high level of innovation across all stages of people's lives is crucial: not only many industry and service sectors are currently looking at ways to leverage AI, but also there is a growing need to educate citizens by providing basic knowledge of AI and how it can affect their everyday life.

According to data collected by CINI in December 2019, coming from official source of MUR, in Italy AI is a fundamental discipline in all Italian Curricula of Computer Science and Computer Engineering at both Bachelor and Master Level with more than 200 AI courses in 50 universities, including 4 AI-specific Masters and 6 Master curricula in AI, all taught in the English language.

However, this is only a small piece of the education puzzle. To complete the picture, we foresee:

- The support of **AI education in schools** (through the newly acquired workforce, see R#3);
- The strengthening of **AI academic courses and curricula** , both at Bachelor and at Master level;
- The development of **new interdisciplinary curricula**, inspired by AI4X, such as AI and Medicine, AI and Mobility, etc.;
- **Accompanying, consolidate, and expand** the **National AI Doctorate Program** expected to start in 2020.
- The support of AI education in **lifelong learning**, reskilling and upskilling AI competences, etc. Not only would individual workers, but more in general many industry and service sectors, who are currently looking at ways to leverage AI, would benefit from such continuous learning and improvement process.
- **Teaching elements of AI** for the society (along the lines of the model proposed in Finland), where each individual citizen would be given the basic tools to understand the rationale, benefits and issues behind the AI and AI-empowered technology.

Cross-cutting topics in AI education, holding at all levels, include **gender issues**: this point particularly regards the issue that AI should deal with the implicit or explicit bias of data and its processing in solutions which guarantee gender balance and equal treatment.

Recommendation #2

Create a new, grand education plan to reinforce, integrate and disseminate AI knowledge at all levels of education.

The plan would involve MI (for school), MUR (for university) and MISE (for the industry side), whereas CINI-AIIS could provide the necessary advice on AI competences and skills. This plan could involve also external stakeholders such as Foundations, Banks, Industries for a long term vision of the AI for future Italy. This plan will be strongly tied to R#3, because the requested human resources will be also aimed at reinforcing teaching and dissemination in the field of AI.

R#3
AI Research Talents

Concerning human resources, the most urgent need is to enable young researchers who have reached a sufficient maturity to undertake their own research, to get a position in the research system, namely **RTD-B for the university system and, similarly, TI for non academic research institutions**. In order to fulfill these positions and, possibly also other positions in the academic systems, a key element would be the attractiveness for young talents. At the current stage there is a strong talent gap, due to the worldwide recruitment by the big industrial players and by attractive offers by other research institutions in Europe. Any means that can make new positions in Italy more appealing at an international scale would be critical for the success of the recruitment.

Italian Academy needs a new young critical mass starting from RTD-B positions, or directly as Associate professors. Also a plan for AI RTD-A + RTD-B should be focused on educating talents in research and academic professorship. Without new manpower Italy cannot be strong enough to deal with the new long-term research challenges in AI and can hardly deal with related initiatives on education at large, technology transfer, supporting actions for society, as standardization, regulations and protections, providing valuable deep expertise to collaborate in all fields requiring a multidisciplinary approach.

As in Germany and in other countries, we need a special plan for AI researchers; to be appealing at international level we should also provide highest salaries, or if not possible, providing economic support such as Ph.D. students, administrative support and lab infrastructures. Similarly to the "Chair AI" in France, or the Fellowship on the Alan Turing Institute in UK, one solution for improving attractiveness could be to create special supporting programs for new RTD-B in AI disciplines. These new people should have strong technical expertise in AI, in computer science and in computer engineering and should work in strict contact with research labs in AI not to be isolated in their research, both in specific Departments where AI is a foundational core and in the Departments where is useful for applied research. As well they should cope with the need of education initiatives at universities and to support specific initiatives of lifelong learning in the productive contexts on in pre-university education.
New researchers could be useful also coming from industries and for foreign institutions to enrich the Italian expertise.

Recommendation #3: create a "**Program for recruitment of AI talents"**, which increases the AI research workforce, by establishing new stable positions for young researchers.

The acquisition of new research positions should be articulated over the years, to ensure both a first boost of AI research and education and to guarantee that the next generation of researchers trained through the AI National Project and the AI National Doctorate exploit their research potential in Italy.

R#4

Nurturing AI development and adoption: Support Actions

For a proper exploitation of the results of the research project and, more generally of AI research in Italy, a number of support actions are foreseen, building on the experience and structure of the EU research framework.

» **A national AI platform.** First, the technology produced by the research projects should be used to feed a national platform (**e-infrastructure**), collecting data and methods to be made available and usable to researchers and innovators. The availability of a unique platform can speed up the realization of new research prototypes and push the technology transfer towards marketable solutions. A national AI platform, not necessary centralized, is not intended to replace the other available tools, rather to complement them with a specific focus on the protection of the Italian know-how and capabilities, in line with the revision of the golden power and on the legislation concerning the "*Perimetro di sicurezza cibernetica nazionale*". Such platform will connect with existing and ongoing EU platforms such as the one under development by AI4EU[1] European initiative and other thematic AI infrastructures such as SoBigData providing resources and tools, and services for Social Mining and Big Data Analytics, and the European Language Grid platform for speech and NLP resources, tools and services.

» **Technology Transfer.** A measure to be implemented is the creation of specialized challenges that are inspired by specific industrial needs and can be pursued through a competition model (e.g. IANUS, DIVA). In such settings, the competitive development of a winning solutions can substantially reduce the time to market for new technologies.

» **Recruitment of PhD personnel (i.e., PhD holders) in Italian industry.** Traditionally Italian companies do not give specific value to PhD personal. This, however, makes it difficult for them to adopt new technologies that are characterized by a very rapid development and whose take-up time, from academic laboratories to the industrial world is very short, as in the prominent case of AI. Several countries, including the United States, UK, Israel and many others, are well aware of this risk and value significantly PhD personnel giving them specific roles with adequate salaries. China started doing this only recently, exactly to gain industrial leadership in AI. To align Italy, a detailed economic study is needed to quantify the deficit that the failure to specifically valorize PhD personnel has brought about in the Italian industry, and to estimate the socio-economic impact that the proposed change of pace would generate. With clear data at hand, then, specific actions must be determined, such as forms of tax relief for companies that hire PhD personnel, so as to generate a virtuous circle of investment toward this change. The Italian AI scientific community is ready to give its full support to this initiative, and to be at the forefront in helping with this necessary change of pace.

A second set of actions is essential to the deployment and penetration of AI technologies. They can be initially addres-

1 https://www.ai4eu.eu/

sed by funding **exploratory working groups** to design a practical path for a responsible introduction of AI systems in the society.

The following is an initial list of general issues that may be at a later stage be structured according to the application domains arising from the AI4X projects:

- I*mpact on Labour Market,* to study impact and policies to anticipate and mitigate the impact on labour and employment;
- *Certification of AI Systems*, to assess the procedures to be implemented for reducing within well defined limits the risks related to the use of AI systems: this issue follows the approach of the "White Paper on AI[2]" by the EU , for the need of an accountable and certified AI, both in its version of pure software/tool for cloud and in its version as edge-AI systems.
- *Ethical Committees,* to provide ethical guidelines for both research activities and commercial systems and to monitor their application. One important action will be to produce guidelines on developing AI systems outlining the definitions, the legal basis for ethics AI and the benefits of acting ethically.

Recommendation #4: create a "**Framework for AI supporting actions"** including AI Technology Platform, AI Technology Transfer, Recruitment of PhD in Industry, and Exploratory Working Groups

The final goals of these supporting actions is to establish, maintain and protect over a long period the national AI know-how. Italian infrastructures, Italian AI companies and all AI producers must be aware on the risks connected with potential economic and/or cybernetics attacks which could aim to depower the Italian power and competitiveness.
As well, the results of research, education strategies and supporting actions should go in the direction of strengthen the Italian independence.

The initiatives must substantiate the fact that if we will not have adequate and competitive national AI systems and services (in terms of algorithms, computational capacity and data), we will have problems of national strategic autonomy thus easily becoming hostages of third nations that may have the power to block the availability/integrity/confidentiality of these systems/services. Therefore also supplies of AI systems must be carefully evaluated by coordinated national working groups.

2 https://ec.europa.eu/info/publications/white-paper-artificial-intelligence-european-approach-excellence-and-trust_en

R#5

Italian AI Infrastructure: The Istituto Nazionale in Intelligenza Artificiale

Research and Innovation in AI, due to its multifaceted and multi-disciplinary nature, needs a strong infrastructural support for realizing the policies and actions defined in the previous Recommendations R#1-4 and regulated as in R#0. AI, in Italy and in the world, has two distinctive characteristics, which call for a specific AI National Infrastructure, namely:

- **AI intrinsically requires a wide range of competences** (in both foundational and applied AI), it flourishes best in large and structured teams of researchers, and strongly benefits from close collaborations and contaminations with local actors in the productive world (companies as well as end users).
- **AI has a long tradition of excellence in Italy** and is already strongly represented in many centers across the whole of Italy. AI competences are already distributed in many physical sites, in university labs and research centers, as witnessed by the more than fifty nodes of the Italian CINI-AIIS Lab, although the number and size of projects varies from node to node (see Figure 4),

Many EU and extra-EU countries governments are regulating the aggregation of existing and newly-created centers (e.g., in France with four ecosystems, in Germany with twelve centers, in UK with Alan Turing Institute collecting many Universities and Innovation Centers). A similar strategy appears extremely suitable for Italy as well, as it would allow to leverage over existing strong realities, it would distribute the economic payoff of investments in AI across the whole country, while at the same time leaving open the possibility to create new dedicated centers, targeting specific scientific, technological and societal needs.

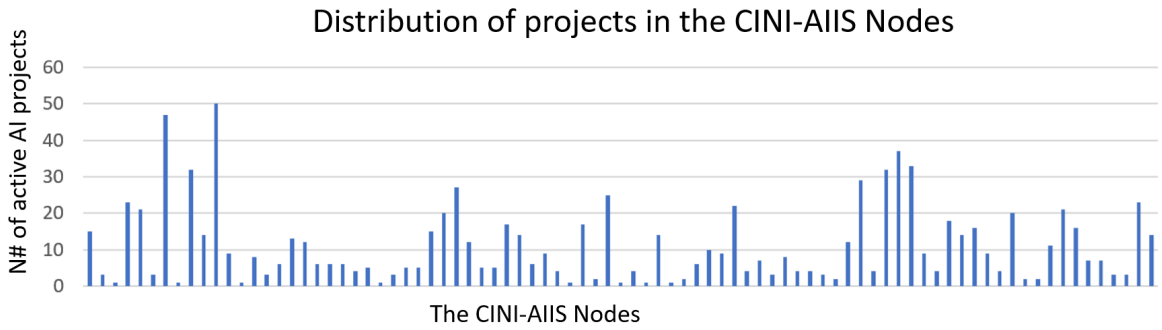

Figure 4: The distribution of projects in the nodes as collected in the CINI-AIIS Survey.

Recommendation #5: Create a National Infrastructure of AI**: the Istituto Nazionale in Intelligenza Artificiale (INIA**)

We propose an infrastructure spread over the whole National territory, organized as follows:

- **"National Labs"** (possibly no more than twenty among the existing ones), characterized by a large concentration of researchers and manpower human resources, physical infrastructures and equipment, excellent scientific output and recognized international standing, as well as active research projects;
- An associated cluster of possibly many **"Sections",** composed by small but focalized research groups;
- one or few **"AI Centers"**, associated to significant AI infrastructure and accessible to all researchers working in Labs and Sites, to be created ex-novo if needed.

INIA should be a stable research infrastructure, that will be devoted to defining national plans such as the 2030 National AI project, education and supporting actions. It should be synergically connected to local and existing Italian research infrastructures, and constitute the AI technological support to all existing initiatives by providing open services, making available hardware and software instruments and human resources. It should become the reference infrastructure to implement national strategies for supporting Trustworth AI adoption in industry and society. It is inspired by the National Institute of Nuclear Physics (INFN), which was initially established by four universities in 1951 and now, after 70 years, is distributed over the whole Italian territory. As INFN INIA should address future long-term research for keeping the scientific role of Italy in AI in the highest world positions. At the same time, given the pervasive nature of AI INIA should be connected with Italian industry, similar to Scale. AI or Ivado Labs in Canada or MediaLab of MIT, USA. INIA should have an academic and research nature and be coordinated with other initiatives, more vertical and devoted to local industry such as European Digital innovation Hubs and Competence Centres.

Artificial Intelligence is currently globally considered the "new Electricity Revolution of our century" and the "kernel of the fourth industrial revolution".

It is imperative for Italy to develop and implement a long term vision for the next decades. Hence, INIA should pursue the following goals:

- **support long-term research activities of existing and future AI research talent**s in Italy, distributed across computer science and computer engineering departments and existing excellent labs, specialized both in foundational topics of AI and in applicative areas;
- **coordinate institutional initiatives** for research and innovation, tech-transfer and regulatory actions, also coordinating the evaluation and the certification of AI products and results;
- **provide a hub for the existing labs and sections** distributed at regional and national level.

The INIA proposal follows the recommendation of a new research centre in MISE's document, but it embeds it in a wider, long-term distributed infrastructure, capable to connect North and South research centres, allowing the mobility of researchers and the cross-fertilization with the local initiatives. As INFN, INIA should have stable funding resources. The actions envisaged in R#1 and R#4 will create the first kernel of funding and resources for INIA.

Conclusions and acknowledgement

The aim of this document has been to present the vision of the Lab CINI-AIIS regarding a possible Italian strategy for Artificial Intelligence for Future Italy, focalized on the scientific research and on its strict connection with Institutions, Industry and Society. As a result of a long fruitful discussion, the CINI-AIIS Vision of "AI for Future Italy" is based on three pillars, namely "*Research, institutions, industries: a big deal",* "I*talian AI research is not an option*" and "*There is no free-lunch Italian AI*". The Italian recipe of AI, similarly to the one of many other European countries, should start from a large coordination and a long term deal with institutions and Italian industries. We, as Italian community of researchers in AI, are willing and ready to cooperate with the priorities defined by Italian institutions in terms of industrial needs and societal challenge and collaborate together through research, education, and supporting actions such as technology transfer. We don't want to lock ourselves in the ivory tower of research, but we want to contribute in the Italian "RenAIssance", as defined in the MISE documents, to strengthen Italian economy and society.

We defined three consequent KPIs to measure results and benchmarking the investments namely "*Research excellence*", "*Coordination between Foundational and Applied Research & Innovation*" and "S*upport to the growth of Italy at all levels*". In our work and in this resulting document we wanted to highlight our awareness that nothing can be done without putting research at the centre and that there is an urgent need to invest in Italian research with structured investments in personnel, projects and infrastructures. Accordingly, we want to suggest Italy to bet on national research, with the goal to have a direct substantial impact in national society and economy.

The document presents six recommendations for c*oordination, research, menpower, education and supporting actions*, together with the *integrated long term INIA infrastructure:* they are the output of our *desiderata* for a strategy of investments in Artificial Intelligence for Future Italy.

We want to acknowledge all colleagues of Lab CINI-AIIS which contributed in the discussion and in this final document.

Italy, 31 January 2020
(Revised 30 April 2020)
The Lab CINI-AIIS