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The Workshop on the History of Artificial Intelligence in Europe

U. Cortés, A. Bugarín & C. Barrué

October 13, 2024

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Workshop on the History of Artificial Intelligence in Europe. Introduction

Cristian Barrué[a], Alberto Bugarín[b] and Ulises Cortés[c,*]

[a]Institut de Robòtica i Informàtica Industrial, CSIC-UPC, Barcelona, Spain
[b]Centro Singular de Investigación en Tecnoloxías Intelixentes (CiTIUS), Univ. de Santiago de Compostela, Spain
[c]Universitat Politècnica de Catalunya & Barcelona Supercomputing Center, UPC-BSC, Barcelona, Spain

Abstract. The Workshop on the History of Artificial Intelligence in Europe (WHAI@AI) offers a comprehensive exploration of AI's evolution on the European continent over the past seven decades. This event aims to provide a nuanced understanding of AI's development, from its theoretical foundations to practical applications, highlighting European researchers and institutions' unique contributions and challenges.

The workshop will examine pivotal moments that have shaped AI in Europe, including breakthrough discoveries, technological advancements, and influential research programs. It will also analyse the interplay between AI development and broader societal, economic, and policy contexts specific to Europe. By tracing the field's progression through various stages - from early symbolic AI to modern machine learning approaches - participants will gain insights into the successes and setbacks that have characterised European AI research.

1 Introduction

The idea to document the histories of AI in Europe arose naturally through a series of informal discussions among AI researchers involved in the HUMANE-AI project [7]. In alphabetic order, the most active were Prof. Frank Dignum, Prof. Luc Steels, Prof. Ulises Cortés and Prof. Virginia Dignum.

Recognising the importance of preserving AI's European heritage, the European Association for Artificial Intelligence board (EurAI) launched a call for proposals to fund this historical documentation project in 2023. However, none of the received proposals secured funding.

After this situation, we proposed hosting a workshop during ECAI2024 to maintain momentum and foster collaboration. This workshop will serve as a crucial platform to initiate a discussion about recording the histories of AI in Europe. We believe that the insights and memories shared by the pioneers in the field will be invaluable in shaping this historical documentation project.

The Workshop on the History of Artificial Intelligence (WHAI@EU) is not the first attempt to explain the History of AI in Europe. We acknowledge and respect the significant contributions of previous efforts, including two papers published ten years ago, one by Prof. Wolfgang Bibel [3] and the other by Prof Eric Sandewall [8]. The European Union's comprehensive report on AI in 2018 [5] and a recent publication by van Essen *et al.* further enriched the historical narrative [9]. Also, there are examples of timelines for AI [10].

* Corresponding Author. E-mail:ia@cs.upc.edu

2 Workshop on the History of AI in Europe

WHAI@AI proposes a captivating exploration of AI's rich and complex evolution on the European continent. This event offers a unique opportunity to delve into the rich tapestry of AI's development, from its theoretical foundations to its practical applications. It spans nearly seven decades of progress and innovation, highlighting the successes, setbacks, and pivotal moments shaping AI in Europe.

Artificial Intelligence, as a scientific discipline, has roots that stretch back to ancient myths of artificial beings. However, its modern incarnation has flourished over the past seventy years, evolving through various stages marked by both triumphs and challenges.

The Workshop on the History of AI in Europe aims to:

1. Provide a comprehensive chronology of AI development across various European countries.
2. Highlight essential themes and advances in European AI research.
3. Recognise key individuals who have been instrumental in shaping AI's trajectory in Europe.
4. Foster a deeper understanding of AI's current state and potential future directions in the European context
5. Produce a list of criteria for admitting new entries into the timeline of AI history in Europe.

The workshop brings together a distinguished panel of experts from various European countries, each offering unique insights into the evolution of AI in their respective regions. Among the notable speakers are:

- E. Alonso, who will explore `The Early Days of the AISB`, offering insights into the foundational period of AI research in the United Kingdom.
- J. Pavão Martins, who will discuss `The Birth of Artificial Intelligence in Portugal`, shedding light on the emergence of AI in this corner of Europe.
- F. Verdejo *et al.* that presents on the `Spanish Association for Artificial Intelligence: story, achievements and challenges`, highlighting Spain's contributions to the field.
- C.K.I. Williams *et al.* who will provide `A Short History of the Early Years of Artificial`

`Intelligence at Edinburgh`, focusing on one of Europe's key Artificial Intelligence research hubs.
- F. Pachet *et al.* who will delve into `Four figures of Parisian Artificial Intelligence research and four questions to ask them`, offering a unique perspective on French Artificial Intelligence pioneers.
- F. Wotawa who will share `European research contributions to model-based reasoning. A personal view`, This paper summarises the contributions of European researchers working on foundations and the application of model-based reasoning.

This event promises to be an enlightening journey through the histories of AI in Europe - from Alan Turing's foundational work to today's deep learning revolution-, offering valuable insights for researchers, students, and AI practitioners.

By reflecting on AI's rich past, we hope to inspire meaningful discussions about its challenges and future possibilities within Europe and beyond. We aim to catalyse discussions that will profoundly influence AI research and development trajectory within Europe and globally.

3 Timeline

The need for a timeline of the history of AI in Europe, supported by the EurAI board, stems from the rapid development and increasing impact of artificial intelligence technologies in recent years. A historical timeline of the history of AI in Europe (see [2]) is valuable for several reasons:

- Tracking Technological Progress. The timeline allows us to track the evolution of AI technologies in Europe, from early conceptual work to today's advanced AI-based systems. Allows to uncover lesser-known European breakthroughs that have shaped the European and global AI landscape. This progression illustrates *how* quickly the field has advanced and why regulations have become necessary.
- Identifying Key Milestones. Decisive events like the European Strategy on AI publication in 2018 [1] and the development of Guidelines for Trustworthy AI in 2019 [4, 6] marked crucial steps in Europe's approach to AI.
- Identifying Key Persons. By examining the contributions of key persons in Europe's AI history, we gain crucial insights that can inform current research, inspire future innovations, shape policy, and strengthen Europe's position in the global AI landscape. This historical perspective is essential for charting a path forward in AI development that aligns with European values and ambitions.

The timeline outlines key moments so far, though many additional items will be incorporated as it continues to evolve. It demonstrates Europe's evolving approach to AI, from initial research and the first EU investments to developing comprehensive regulatory frameworks. It highlights the EU's commitment to fostering AI excellence while ensuring responsible and trustworthy development, positioning Europe as a global leader in responsible AI governance.

3.1 Criteria

This initiative aims to capture and preserve the rich history of AI development in Europe, ensuring that key contributions and milestones are not lost to time.

By establishing thoughtful criteria for creating a European AI timeline, we can ensure a comprehensive and nuanced understanding of AI's development in the region, supporting better policy decisions, research directions, and public discourse on AI in Europe.

4 Acknowledgements

We thank the WHAI@EU Program committee for their work, We thank the EurAI board and IOS Press for their invaluable support in making this workshop possible.

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The Early Days of the AISB

Eduardo Alonso[a,*]

[a]Artificial Intelligence Research Centre (CitAI), City St George's, University of London
ORCID (Eduardo Alonso): https://orcid.org/https://orcid.org/0000-0002-3306-695X

Abstract. Let me ask you, what do you know about the The Society for the Study of Artificial Intelligence and Simulation of Behaviour (AISB)? You may know that we are celebrating the society's 60th anniversary and hence that it was founded in 1964. You may also know that it is a member of EurAI, that it publishes the AISBQ, and that it organises an annual convention. You may also know that one Eduardo Alonso, who, incidentally, is by no means a professional historian, acted as vice-chair of the AISB between 2003 and 2006. Well, maybe not.

To provide the reader a broader view, in this short paper I am giving a quick account of the first years of the AISB, that is, of the period during which, paradoxically, the AISB was not the AISB strictly speaking.

1 The origins

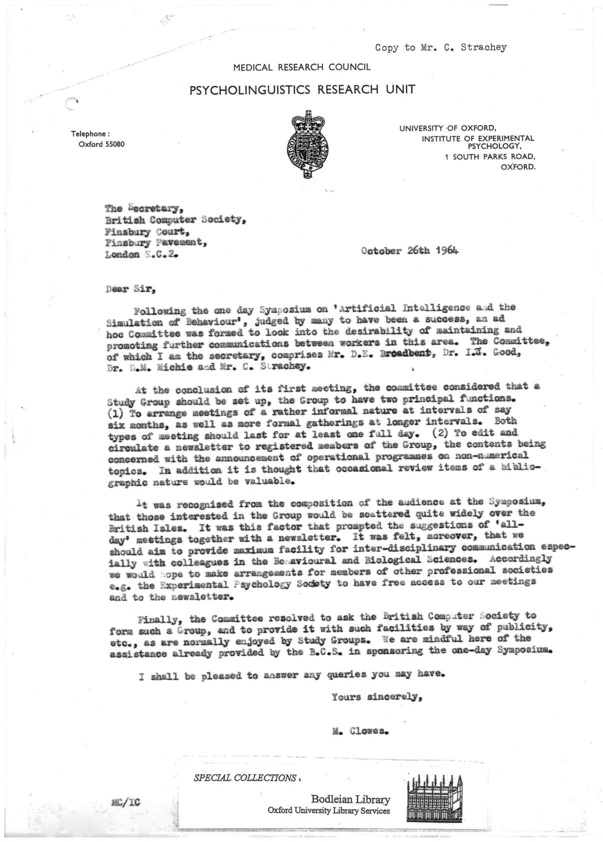
In October the 26th 1964, after a one-day "Symposium on Artificial Intelligence and Simulation of Behaviour" Max Clowes writes to the British Computer Society (B.C.S.) to form a Study Group –with two main objectives, namely, to arrange meetings, and to edit and circulate a Newsletter (Figure 1). It receives a favourable response from the B.C.S. the 20th of November. The symposium itself was held in September 1964 at the Northampton College of Advanced Technology (C.A.T.), later to become City University, at Northampton Square, London, and organized, most likely, by Robin Milner. The discovery of this fact came as a surprise to the author of this note since he has been working at City University, now City St George's, University of London, since 2001.

The AISB is established as the "British Computer Society Study Group on Artificial Intelligence and Simulation of Behaviour". The AISB as we know it, a learned society independent of the B.C.S., will be established in 1974 (see later).

In its foundational document, an AISB steering committee is appointed, consisting of Donald Broadbent, Irving John Good, Donald Michie, Christopher Strachey and Max Clowes, secretary and "dogsbody". Max Clowes will later serve as first Chair between 1969 and 1972, followed by Bernard Meltzer (1972–1976).

To give the reader some perspective, the A.C.M. SIGART was founded in 1966, and the IJCAI corporation in 1969; the AAAI dates from 1979, and ECCAI from 1982. Thus, the AISB is, in fact, the eldest AI society in the world.

Within the U.K., Michie's Experimental Programming Unit was established in 1965, before becoming the Department of Machine Intelligence and Perception in 1966 (joined by H. Christopher Longuet-Higgins' Theoretical Section and Richard Gregory's Bionics Research Laboratory); the famous "Machine Intelligence Workshop" series were inaugurated in September 1965; and in the same year, a diploma course in Machine Intelligence Studies (with 5 students) was first delivered. Research-wise, this is the time of MENACE, Graph Traverser, POP-1, and FREDDY I.


Copy to Mr. C. Strachey

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OXFORD.

The Secretary,
British Computer Society,
Finsbury Court,
Finsbury Pavement,
London E.C.2.

October 26th 1964

Dear Sir,

Following the one day Symposium on 'Artificial Intelligence and the Simulation of Behaviour', judged by many to have been a success, an ad hoc Committee was formed to look into the desirability of maintaining and promoting further communications between workers in this area. The Committee, of which I am the secretary, comprises Mr. D.E. Broadbent, Dr. I.J. Good, Dr. D.M. Michie and Mr. C. Strachey.

At the conclusion of its first meeting, the committee considered that a Study Group should be set up, the Group to have two principal functions. (1) To arrange meetings of a rather informal nature at intervals of say six months, as well as more formal gatherings at longer intervals. Both types of meeting should last for at least one full day. (2) To edit and circulate a newsletter to registered members of the Group, the contents being concerned with the announcement of operational programmes on non-numerical topics. In addition it is thought that occasional review items of a bibliographic nature would be valuable.

It was recognised from the composition of the audience at the Symposium, that those interested in the Group would be scattered quite widely over the British Isles. It was this factor that prompted the suggestions of 'all-day' meetings together with a newsletter. It was felt, moreover, that we should aim to provide maximum facility for inter-disciplinary communication especially with colleagues in the Behavioural and Biological Sciences. Accordingly we would hope to make arrangements for members of other professional societies e.g. the Experimental Psychology Society to have free access to our meetings and to the newsletter.

Finally, the Committee resolved to ask the British Computer Society to form such a Group, and to provide it with such facilities by way of publicity, etc., as are normally enjoyed by Study Groups. We are mindful here of the assistance already provided by the B.C.S. in sponsoring the one-day Symposium.

I shall be pleased to answer any queries you may have.

Yours sincerely,

M. Clowes.

MC/IC

Figure 1. Letter to the British Computer Science to support the formation of the AISB Study Group.

In a more mundane tone, we were still using pre-decimal currency in the U.K., shillings and denarii. According to the opening balance of the "A is B", as the society was mockingly coined by Max Clowes, the original contribution of the B.C.S. was £10 and the subscription 10/- -.

The relationship between the AISB and the B.C.S. was an uneasy one from the very beginning. In a letter from Rod Burstall to C. Strachey dated November 1966, on the occasion of organising the 1967 AISB meeting at the Atlas Computer Laboratory, Chilton, we read

* Corresponding Author. Email: E.Alonso@city.ac.uk.

that "the B.C.S. regard symposia as fund-raising affairs (. . .). They have been charging admission fees of 5-7 guineas (. . .)"; Strachey's reply reflects clearly the society's dissatisfaction with this state of affairs: "I find the B.C.S. attitude quite deplorable. Their function should surely be to encourage the development of specialist groups, not to try to make money from them. (. . .) I should be in favour of severing all connection with them. (. . .)".

From the first Membership List (60 members, May 1st 1965) we learn that AISB research was not exclusively focused in Edinburgh, as one is sometimes led to believe; and that there was a genuine interest in bringing together researchers from different academic areas and also from industry (Elliott Brothers, IBM), the Government (the Ministry of Aviation, the Middle East Command), the Bank of England, the BBC ... Special mention goes to psychology: it was not a coincidence that two out of the five members of the original AISB steering committee, D. Broadbent and M. Clowes, were psychologists, as there were other heavyweights such as Nicholas Mackintosh; that members of the Experimental Psychology Society ""should have free access to our meetings and to the newsletter"; and that the Medical Research Council were actively involved in the society's activities during the 60s. Somehow, this changed over the years, with the AISB becoming more AI and less SB.

2 The Quarterly

It is precisely the Quarterly what better defines the AISB and the best source of information about these first days of the society. So, it is worth examining its trajectory: The Quarterly starts as the "AISB Newsletter" edited by, who else, Max Clowes; from Issue 3, April 1966, Rod Burstall and Jim Doran take over; and under Pat Hayes' editorship it becomes "the European AISB Newsletter" in July 1969; then it is briefly transformed into the "Bulletin" between November 1972 and February 1973, with E.W. Elcock and A. Ortony. Their editorial strategy was not welcomed: in a letter to the Cttee., Feb 22 1973, they propose a "good solution" to the editors' difficulties, "to amalgamate with its sister –SIGART Newsletter". Clowes' answer settles the issue "(. . .) the Elcock-Ortony proposal is appalling. With less that 12 months of taking on the (admittedly difficult) task of editing the Newsletter they want to throw it into SIGARTs lap. I protest strongly." As a consequence, we are back to the European Newsletter, Issue 14, July 1973, this time with Alan Bundy and M. Liardet as editors (Figure 2); and, eventually, the Quarterly sees the light of day, in October 1977 Issue 28, with Tim O'Shea (and a team of sub-editors including B. Welham, R. Young and G. Plotkin, and, later, C. Mellish and L. Daniel). At some point, there was a debate about handing production and distribution of the Quarterly to professional publishers (North-Holland) in 1978-79, that is, about becoming an appendix to the AI Journal, but the suggestion did not prosper.

Speaking of which, it is good to remember that the AISB was instrumental in launching "Artificial Intelligence", published by Elsevier and sponsored by A.C.M. SIGART. It is not a coincidence that B. Meltzer was proposed as the first Editor-in-Chief, or that Tony Cohn, AISB chair between 1992 and 1994, acted as such in 2007-2014.

3 The Convention

As for meetings, there were plenty: one-day scientific meetings, with invited speakers from "Machine Intelligence" workshops, one-day specialised meetings (in chess, theorem proving, robotics, . . .), and summer schools, typically hold in London (I.C.L., Q.M.C., C.A.T.),

Figure 2. AisB's European attempt, 1973.

or "around" the Home Counties (Oxford, the Atlas Computer Laboratory, Sessex, . . .). And, of course, the first conference, organised in Brighton 1974 by Keith Oatley and Margaret Boden, followed by Edinburgh 76, Hamburg 78, and Amsterdam 1980, which were in fact European. The founding ECAI, Orsay 82, preceded the split of the society (see later), and of the conferences, with the AISB convention and ECAI alternating years from Exeter 83 and Pisa 84, except in 1996 (Sussex and Budapest respectively); a joint conference in Brighton 1998 was followed by the final separation.

The relation between the AISB and Europe can be traced back to 1969: Newsletter's Issue 8 informs that during the first IJCAI "a special meeting for the European delegates" was held, resulting in Erik Sandewall reporting that the "British" AISB Newsletter becomes the "European Newsletter for Artificial Intelligence and Simulation of Behaviour", to be produced by Uppsala University, distributed from Edinburgh, and edited by Pat Hayes: "It seems likely that for a while at least we will function as a kind of European AisB, until other national groups are formed on the continent"; . . . until means 1982, when the European Coordinating Committee for Artificial Intelligence (ECCAI, now EurAI) is founded with the AISB as a member.

4 AISB three main characteristics

Browsing through the first newsletter/quarterly issues one finds three recurrent themes that, to a certain extent, define the AISB even today, namely,

- Money (lack of): ToC Issue 9, November 1969, puts it rather explicitly: "MONEY *** IMPORTANT ***"; as it does J. Doran's letter to B. Meltzer, 18 Jan 73: "There is about – £5 in the kitty now";

- Believe it or not, (lack of) contributions to the Quarterly: 22nd April 69 letter from Pat Hayes to AISB members reads "(...) only one contribution had been sent to the editor (...)";
- Tongue-in-cheek attitude: One of my favourite examples is M. Liardet and A. Bundy's Report on the AISB Scientific Meeting January 5th 1974, "(...) was badly hit by the power crisis and the railway worker's dispute (...) but the numbers were boosted to about 30 by Edinburgh workers. The meeting took place in a cold lecture theatre on a cold wet Saturday. Hopes of some relief over lunch were dashed when we arrived in an even colder refectory to face an (airline type) salad. (...)", closely followed by a hilarious advertisement: "ATTRACTIVE SCOTTISH ACADEMIC enjoys affluent life-style – fast cars, expensive holidays, excellent software environments, beautiful Georgian flat, etc. Highly successful, tenured, respectable publications (AI Journal, Cognitive Science, etc.), large grant-holder. Into Szechuan cooking, Baroque music, Linton Kwesi Johnson, jogging, backpacking, and wholefoods. Seeks sincere, object-oriented woman for discreet, loving relationship and mutual simulation. Send 1024 x 1024 pixel image in RT-11 format. Box-MC68000" (Issue 39, Dec 1980). These pranks were accompanied by sections like Brady's cryptic crossword, Aguirre's Wyno the Learning Computer cartoons, limericks, a section of Silly Acronyms (e.g., PROLOG: PRObably the Language Of God), and, of course, the contributions of Father (Alesyus) Hacker, whose identity is one of the best kept AI secrets since Bletchley Park –all the author can say is that, by July 1979, the list included Benedict du Boulay, Alan Bundy, Chris Miller, Hal Abelson, Gordon Plotkin, and Tim O'Shea. So rumour has it.

5 The AI Winter and the AISB

Back to historical facts, from early 1972 D. Michie promotes the idea of a learned society, and in a letter dated 26th Jan 73 M. Clowes confides his fears to B. Meltzer "I feel that the long term view of the AISB is hanging by a thread (...)". It must have been clear by then that the "Lighthill Report", eventually published in 1973 for the Science Research Council (the S.R.C., akin to today's UKRI) was not going to be complementary. And indeed it was not. Sir Michael James Lighthill's "Artificial Intelligence: A General Survey" [1] was followed by the famous BBC debate "The General Purpose Robot is a Mirage" and many comments –by N.S. Sutherland, H.C. Longuet-Higgins, D. Michie, R. M. Needham ... and John McCarthy. Yet, in the author's humble opinion, the best reflection appeared in the AISB European Newsletter July 1973 Issue 14: "Serendipity Resources Council, The Darkvale Report on Applied Mathematics, A Cardboard Conference" by Sir Gorgam Darkvale, F.R.S. Caucasian Professor of Divinity, University of Grantabury, and Pat Hayes' "Some Comments on Sir James Lighthill's Report on Artificial Intelligence". Their reading should be mandatory in any AI course.

As an aside, R. Needham's role in this affair is perplexing: In October 1982, he and P. Swinnerton-Dyer enthusiastically supported the S.E.R.C. (the then Science and Engineering Research Council, today's EPSRC) Alvey Programme in a pamphlet, "Artificial Intelligence Research in the UK", that argues that Lighthill was right then, in 1973, but that he would have been wrong in 1982. To make it up for, a new brand is all it was needed: Intelligent Knowledge Based Systems, IKBS, is born.

Nevertheless, despite accepted wisdom, the AI winter seems to have been rather mild: in 1972, the S.R.C. Long Range Computing Policy Panel recommended the creation of at least one more major centre of Machine Intelligence; Meltzer's "S.R.C. policy with respect to senior appointments on research grants in universities", April 4th 1973, was adopted by the council; the S.R.C. set up a standing Artificial Intelligence Panel in 1974; in 1974-75 the first AI courses are launched in Edinburgh and Sussex, as well as a cognitive studies programme in Sussex; the S.R.C. promotes the creation of a computing network between Edinburgh, Manchester, A.C.L. and the S.R.C. Rutherford Laboratory in July 1976; S.R.C. Interactive Computing Facilities Committee sets up a special interest group to provide advice on software requirements for AI in July 1977 (with A. Sloman (Chair), R. Burdstall, A. Bundy, M. Brady, A. Smith and P. Kent); S.R.C. grants are still awarded to Edinburgh staff, including Michie ... Perhaps the best example that the crisis was not as severe as first feared is the fact that the AISB survives: the first conference takes place, there is a steady growth in membership numbers, the newsletter is published regularly, and, importantly, it becomes a learned society.

6 The AISB proper

Minutes of the Cttee meeting 11 April 1973 report that: "Donald Michie expressed that, in his view, the essentials of such a society were that: – i. It possessed a formal constitution, ii. It was therefore subject to democratic safeguards eg rotation of committee membership, iii. Membership was not automatic – a minimal requirement was that a candidate must be proposed by an existing member, iv. It existed as a legal entity, not merely as a group of individuals. Donald Michie argued that if the Study Group were reformed in this way it would be taken more seriously by the outside world and by its own members." ACTION: Meltzer and Michie to prepare a draft constitution.

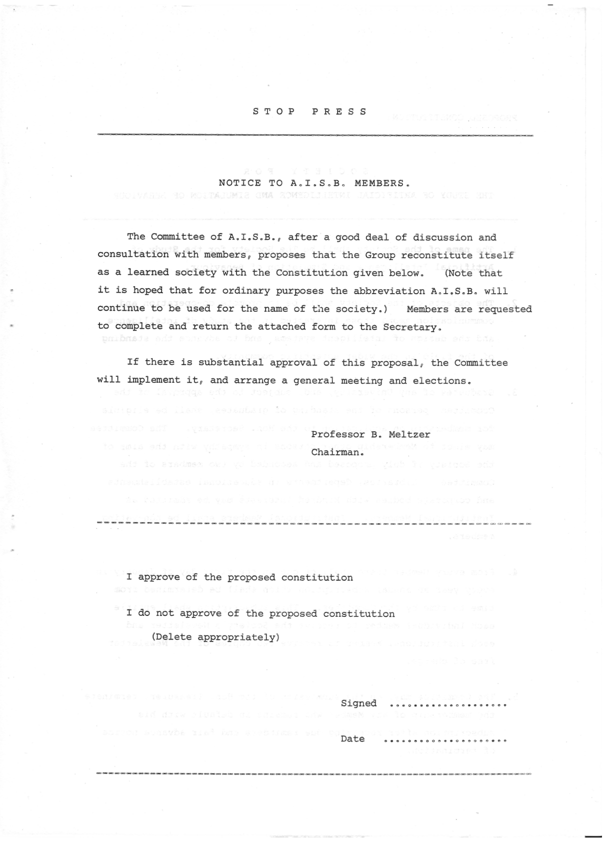
Events followed: the Constitution is proposed in Issue 17, July 1974 (Figure 3); and approved (with only one nay) in October 1974 (then revised in 1977 for charitable status).

7 Europe and all that

Shortly after becoming the AISB, a problem arises: "the issue is whether we work towards separate national "AISB"'s (...) or a single continental organisation. Current political theory calls for the latter, sited in Brussels, with a bureaucracy of around one thousand!", from M. Brady's chairman message Nov 76. Jörg Siekmann (then in Essex) had reported on "German Intelligence Becomes Artificial" in November 74, and by 1977 the German AI Study Group had grown strong, with their own Newsletter and increasing governmental funding. In July 1977 there are mixed signals: "The European AISB Newsletter" becomes the (not explicitly European) "AISB Quarterly" ... and announces that the next AISB Summer Conference will be held in Hamburg.

Then, Wolfgang Bibel from IFI Munich circulates a proposal for the creation of the EAAI, Oct 79, arguing that "most people (...) regard it (the AISB) as a British society", and proposing a board with two representatives from Britain and one from each of France, Germany, Italy, Benelux, Scandinavian and Eastern Europe.

Pat Hayes, among others, is against it: "I can't support this idea. I strongly believe (...) would be a disastrous mistake. I also think that your (Bibel's) motivation in wishing to set it up reflects priorities and views on science and nationalities which are wrong (...) There is no room for a second organization, the entire European AI production is smaller than Stanford's (...) EAAI is going to directly compete with AISB". Facts though are stubborn things:



STOP PRESS

NOTICE TO A.I.S.B. MEMBERS.

The Committee of A.I.S.B., after a good deal of discussion and consultation with members, proposes that the Group reconstitute itself as a learned society with the Constitution given below. (Note that it is hoped that for ordinary purposes the abbreviation A.I.S.B. will continue to be used for the name of the society.) Members are requested to complete and return the attached form to the Secretary.

If there is substantial approval of this proposal, the Committee will implement it, and arrange a general meeting and elections.

Professor B. Meltzer
Chairman.

I approve of the proposed constitution

I do not approve of the proposed constitution

(Delete appropriately)

Signed ....

Date ....

Figure 3. Democracy in action, *the* AISB.

- Fog had not cut off the Continent: AI groups in Europe had proliferated in the 70s;
- Although there is no mention of Britishness in the AISB Constitution, there is little involvement of continentals in the Cttee: E. Sandewall serves from 1969 to 1975, then he is not nominated in first ballot;
- It is acknowledged that currency is an issue for "foreigners in joining AISB" (Sept 78);
- The Hamburg conference is a huge success, boosting confidence of continental members.

And "Europe" was not the only problem: "AISB disciplines" started to form their own societies, e.g., the British Robot Association (by Larcombe, 1977); in the late 70s Donald Michie himself founds the B.C.S. Special Group on Expert Systems –to become BCS-SGAI in June 1980; psychologists feel alienated and join the new Cognitive Science Society in 1979.

It was a brave new world.

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The Birth of AI in Portugal

João Pavão Martins[a,*]

[a]Instituto Superior Técnico, University of Lisbon

Abstract. This paper traces the emergence of AI in Portugal, beginning with a small group working in Prolog at the National Laboratory of Civil Engineering in the mid-1970s. It explores the journey of its members, the initial surge in the mid-1980s when several AI PhDs joined Portuguese universities, and their pioneering contributions. Additionally, it briefly outlines the evolution of AI work in Portugal up to the 2020s.

1 Background

The origin of AI in Portugal goes back to the mid-1960s, when professor António Gouvêa Portela (1918-2011) [10], [17] of Instituto Superior Técnico (IST) established the Center for Cybernetics Studies (CEC). Among its members was Luís Moniz Pereira, an Electrical Engineering student, who later earned a PhD in Cybernetics. Helder Coelho, also studying Electrical Engineering at IST, joined CEC in the late 1960s.

In 1973, Luís secured a research fellowship at the Department of Computational Logic[1] of the University of Edinburgh. Returning to Portugal, Luís worked at the National Civil Engineering Laboratory (LNEC). In 1973, Helder Coelho joined him as a research assistant. One of their initial works was the development of a Prolog-based plane geometry theorem prover [32], published in 1986 [33].

2 LNEC's AI Group

In 1975, a small AI group was formed at LNEC, comprising Luís Moniz Pereira, Helder Coelho, and Fernando Pereira.[2] Luís and Fernando worked on one of the earliest implementations of Prolog for DEC System-10 computers, with close ties with David H. D. Warren at the University of Edinburgh. They played a pivotal role in disseminating Prolog to the international scientific community and published the first English paper on Prolog [118].

Professor Portela, an educator and innovator, gathered undergraduate students in the basement of his house on Thursday evenings for extra-curricular readings, preparing them for future PhDs. In 1973, João Pavão Martins and Ernesto Morgado were invited to join these sessions. In 1975, during one of these sessions, Prof. Portela presented a paper on perceptrons, their application to learning, and discussed advances in AI. From their enthusiasm, he suggested they start with an internship at LNEC, working with Luís and Helder. Salvador Abreu joined LNEC's AI group in 1977.

Within this group, Helder, under Luís's supervision, and Fernando, under David H. D. Warren's supervision, pursued their PhDs studies, earning their degrees from the University of Edinburgh in 1980 and 1982, respectively. João and Ernesto, were introduced to AI through this group, learned Prolog and secured a Fulbright scholarships to pursue PhD studies in AI at the State University of New York at Buffalo, completing their degrees in 1983 and 1986, respectively, before returning to IST as Assistant Professors.

Salvador joined Universidade Nova de Lisboa (UNL), earning his PhD in 1994 under Luís's guidance. Alongside with José Alferes, who also obtained his PhD in 1993 under Luís's guidance, they moved to the University of Évora, where they co-founded the Computer Science program and the Department of Computer Science.[3]

LNEC's group served as the cornerstone of AI in Portugal. Its members, after obtaining their PhDs, promoted the discipline within their universities and established AI research lines in various centers. Fernando Pereira diverged from this path, pursuing a distinguished career in the US, working at institutions such as Stanford Research Institute, Bell Labs, University of Pennsylvania, and Google, where he became VP and Engineering Fellow.

3 The First Expansion

The first expansion of AI in Portugal began around 1984. Alongside the efforts of Luís and Helder, other researchers, most of them had obtained PhDs in AI at universities outside Portugal, emerged at several Portuguese universities:

- Pavel Brazdil at the Faculty of Economics of the University of Porto (FEcUP);
- Ernesto Costa at the University of Coimbra (UC);
- João Pavão Martins and Ernesto Morgado at IST;
- José Maia Neves at the University of Minho (UM);
- Eugénio Oliveira at the Faculty of Engineering of the University of Porto (FEUP);
- Miguel Filgueiras and Luís Damas at the Faculty of Sciences of the University of Porto (FCUP);
- António Porto at UNL.

These individuals started to work in universities where Computer Science degrees were largely absent, the schools were not prepared for offering AI courses and there was no research being done in AI. Through their pioneering efforts, they established the necessary infrastructure and curriculum to facilitate AI education and research.

Under Luís's initiative, the Portuguese AI Association (APPIA)[4] was founded in 1984. From 1985, APPIA started organising the Portuguese AI Conferences (EPIA), and from 1988, the Advanced AI School (EAIA).

* Corresponding Author. Email: jpmartins@siscog.pt

[1] The Department of Computational Logic, founded in 1969, was Europe's first AI center, stemming from a research group established in 1963 by Donald Michie (1923-2007).

[2] Recently graduated in Mathematics from the University of Lisbon.

[3] https://www.dinf.uevora.pt

[4] http://www.appia.pt

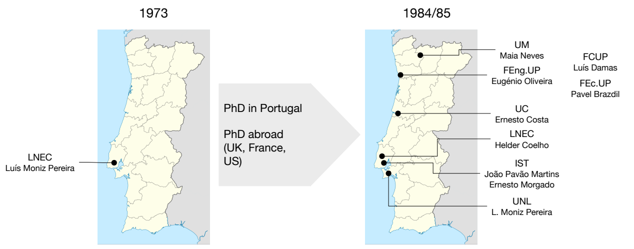

Figure 1. Evolution of Portuguese AI groups from 1973 to 1985.

While the initial AI work in Portugal revolved around Prolog and logic programming, other research groups began introducing LISP to the country, notably led by Ernesto Costa, João Pavão Martins, and Ernesto Morgado.

4 The Pioneers

Presented in the chronological order of PhD completion.

4.1 Luís Moniz Pereira

Luís Moniz Pereira began his journey in AI at CEC. He translated Gordon Pask's book, *An Approach to Cybernetics*, into Portuguese. Impressed by the translation, Gordon Pask (1928-1996) invited Luís to study with him. Luís earned his PhD in Cybernetics from Brunel University in 1974 [83].

After submitting his thesis and before its defence, Luís got a research fellowship position at the Department of Computational Logic of the University of Edinburgh, where he fell in love with Prolog and logic programming, themes that would define his career. Returning to Portugal, he joined LNEC, where he formed an AI group, initially comprising Helder and Fernando, later joined by João, Ernesto, and Salvador.

In 1978, Luís left LNEC to join Universidade Nova de Lisboa (UNL), that started to offer a two-year terminal degree in Computer Science for undergraduate students that had completed the first three years in other areas.[5] This was the first degree in Computer Science in Portugal. At UNL, from 1979, he formed a research group whose members were António Porto, Eugénio Oliveira, Paul Sabatier, and Miguel Filgueiras, focusing on advancing logic programming with applications in natural language.

In 1991, Luís contributed to the establishment of CENTRIA (Center for Research in AI),[6] at UNL where he played a pivotal role in nurturing researchers. In 2008, CENTRIA merged with CITI (Research Center for Interactive Technologies) to form NOVA LINCS,[7] aiming to foster collaboration rather than competition in the IT field.

Luís is Emeritus Professor at UNL since 2022.

He was the author and co-author of the books: "How to Solve it with Prolog" [34]; "Reasoning with Logic Programming" [1]; "A Máquina Iluminada - Cognição e Computação" [85]; "Programming Machine Ethics" [94]; "On Morals for Machines & the Machinery of Morals" [87]; and "Machine Ethics: From Machine Morals to the Machinery of Morality" [91].

Working Areas

Logic Programming [2]; Natural Language [97]; Bactracking [98]; Debugging in Prolog [90]; Paraconsistent Logics [42]; Counterfactuals [89]; Hypothetical Reasoning [99]; Non-monotonic Reasoning [100]; Reasoning about Actions [52]; Abduction [3]; Negation in Prolog [88]; Temporal Reasoning [51]; Parallel Processing [84]; Belief Revision [101]; Argumentation [92]; Learning [48]; Agents; Expert Systems [96]; Evolutionary Computation [6]; Cognitive Science [86]; and Machine Ethics [93].

PhD Supervisions (and date of completion)

Helder Coelho (1980); António Porto (1982); Eugénio Oliveira (1984); Miguel Filgueiras (1984); José Cardoso e Cunha (1989); Miguel Calejo (1992); José Alferes (1993); Joaquim Aparício (1994); Salvador Abreu (1994); Carlos Damásio (1996); Michael Schroeder (1998);[8] João Alexandre Leite (2002); Jorge Simão (2003); João Alcântara (2008);[9] Alexandre Pinto (2011); The Anh Han (2012);[10] Mário Abrantes (2013); Ari Saptawijaya (2015);[11] Emmanuelle-Anna Dietz (2018);[12] Abeer Dyoub (2019).[13]

4.2 Helder Coelho

Helder Coelho's research career started at INETI[14] (ex-LFEN[15]) in 1968. In 1973 he moved to LNEC. Helder earned his PhD in 1980 from the University of Edinburgh, under the supervision of Luís and David H. D. Warren [22]. His thesis focused on developing a program in Prolog, TUGA, capable of conversing in Portuguese and providing library services, enabling natural language searches for articles and books. Helder endeavored to align his research with the interests of LNEC, applying his work to enhance LNEC's library [23].

During his tenure at LNEC, together with Luís he founded the first informal AI Portuguese group. He participated in this group until 1978, assuming its leadership when Luís departed for UNL. In 1983, he became Principal Investigator at LNEC, dedicating sixteen years to coordinating research projects at this institution.

While at LNEC, he served as an Invited Assistant Professor at the Faculty of Sciences of the University of Lisbon (FCUL) from 1981 to 1983, teaching AI. From 1985 to 1989, he also held the position of Associate Professor at Instituto Superior de Economia e Gestão (ISEG) of the University of Lisbon where he co-founded the Mathematics Department in 1986. During this period, he was responsible for IT courses in Economics and Management Degrees, as well as AI and Knowledge Systems courses in the Master's Degree program.

In 1990, he left LNEC to occupy the position of Full Professor at ISEG, assuming leadership of the Fundamentals of AI course in the Degree in Mathematics Applied to Economics and Management. He founded the Information Technologies and Sciences group and concurrently joined INESC[16] in 1990 as Project Head, leading the establishment of an AI team. He contributed to ESPRIT projects and international cooperation initiatives with AI groups at University of Birmingham (UK), Institute of Psychology of CNR in Rome (Italy), University of National Distance Learning Center in Madrid (Spain), Leibniz Institute of IMAG/CNRS (France), Polytechnic School of State University of São Paulo (Brazil), and the Federal University of Rio Grande do Sul (Brazil).

[5] At that time, undergraduate degrees in Portugal required five-year study.
[6] `https://centria.csites.fct.unl.pt`
[7] `https://nova-lincs.di.fct.unl.pt`

[8] Currently responsible for the Biotechnology centre at the Technical University of Dresden, Germany.
[9] Currently Adjunct Professor at the Federal University of Ceará, Brazil.
[10] Currently, Professor of Computing at the Faculty of Computing, Engineering and Digital Technologies at Teesside University, UK.
[11] Currently, Professor of Informatics at the Faculty of Informatics, University of Indonesia.
[12] Currently at Airbus Atlantic, Research & Technology.
[13] Currently, PostDoc Fellow at the Department of Computer Science, Information Engineering, and Mathematics, University of L'Aquila, Italy
[14] National Institute of Engineering, Technology and Innovation.
[15] Nuclear Physics and Engineering Laboratory.
[16] `https://inesc.pt`

In 1995, he became Full Professor at FCUL. He co-founded the Center for Complexity Sciences (C3) at the Faculty of Sciences, fostering interdisciplinary collaboration to address complex issues. From 1998, he served as Scientific Coordinator of the Computational Models and Architectures Lab (LABMAC) at C3, and, in 2004, of the Agent Modelling Lab (LabMAg). Within LabMAg, he co-founded the Institute of Complexity Sciences, serving as its President from 2004 to 2007. In 2007, he played a pivotal role in establishing Master's and PhD programs in Complexity Sciences and in Cognitive Science.[17]

In 2015, he co-founded Colégio Mente Cérebro[18] (CMC) at the University of Lisbon, aimed at fostering transdisciplinary scientific activities and exploring the interface between mind, brain, and society. CMC includes faculty members from Sciences, Pharmacy, Arts, Medicine, Psychology, and IST.

Helder received formal recognition for his contributions to AI from various communities, including the Brazilian AI community at SBC and SBIA Conferences (2010), the Latin American AI community at IBERAMIA 2010 Conference, the Portuguese AI Association during EPIA Conference (2013), and the Federal University of Bahia (Brazil) during its 70^{th} anniversary celebration (2016).

Helder Coelho is Emeritus Professor in the Department of Informatics at the Faculty of Science and Technology of the University of Lisbon. Since 2021, he has been a member of LASIGE, an R&D unit at the Faculty of Sciences of the University of Lisbon, focusing on Computer Science and Engineering.[19]

He is the author and co-author of over 25 books, including "Prolog by Example" [31], "Inteligência Artificial em 25 Lições" [26], "Sonho e Razão, Ao Lado do Artificial" [27], and "Explorações, Ligações e Reflexões: Rede de 30 anos de pesquisas em IA com sentido prático" [28].

Working Areas

Intelligent Buildings [25]; Agents [115]; Natural Language [24]; Multi-agent Systems [113]; Learning [116]; Knowledge Engineering [110]; Social Simulation [7]; Autonomous Systems [29]; Affective Computing [9]; and Complex Systems [50], [30].

PhD Supervisions (and date of completion)

José Carlos Cotta, investigador do Estado (1986); Gabriel Pereira Lopes (1987); José Távora, investigador do Estado (1989); Rosa Maria Viccari (1990);[20] Milton Corrêa (1994);[21] Graça Gaspar (1994); Luis Botelho (1997); Jorge Louçã (2000); Marcelo Ladeira (2000);[22] José Castro Caldas (2000); Luis Antunes (2001); João Pedro Neto (2003); João B. Silva (2003); Luis Moniz (2003); Paulo Urbano (2004); Nuno David (2004); Cecília Flores (2005);[23] Francisco Coelho (2006); Leonel Nóbrega (2007); Paulo Silva (2007); Paulo Trigo (2007); Victor Cardoso (2007); José Cascalho (2008); Marcia Franco (2008);[24] Carlos Lemos (2016); Nuno Magessi (2018); Daniele Sandler (2018);[25] Nuno Henriques (2020).

[17] https://dcicog.edu.ciencias.ulisboa.pt/?lang=en and https://www.ulisboa.pt/en/node/37384
[18] https://www.ulisboa.pt/en/info/mind-brain-college
[19] https://www.lasige.pt
[20] Currently, Full Professor at the Institute of Informatics at the Federal University of Rio Grande do Sul, Brazil.
[21] Currently in Brazil.
[22] Currently, Adjunct Professor in the Department of Computer Science at University of Brasília, Brazil.
[23] Currently, Associate Professor at the Federal University of Health Sciences Foundation of Porto Alegre, Brazil.
[24] Currently, professor at the Federal Institute of Education, Science and Technology of Rio Grande do Sul, Porto Alegre, Brazil.
[25] Currently, Advisor to the Risk Management Board of Banco do Brasil S/A.

4.3 Pavel Brazdil

Pavel Brazdil obtained his PhD in 1981 in Learning at the University of Edinburgh under the supervision of Gordon David Plotkin [11]. His career was at the Faculty of Economics of the University of Porto, becaming Full Professor in 1998, retiring in 2015, but continuing his research. In 2008, he was named fellow of EurAI, the European Association for AI (formerly ECCAI). In 2019, he was honoured by the Portuguese Association for AI for his services to the community.

In 1988, he founded the AI and Decision Support Lab (LIAAD)[26] at FEcUP, currently one of the INESC TEC centres in Oporto. He was a pioneer in the area of metalearning.

Pavel is Emeritus Professor of FEcUP.

He was one of the authors of the books "Metalearning: Applications to Data Mining" [14] and "Metalearning: Applications to Automated Machine Learning and Data Mining" [15].

Working Areas

Learning [13]; Data Analysis [35]; Logic Programming [12]; Agents [16]; and Computational Biology [117].

PhD Supervisions (and date of completion)

Alípio Jorge (1998); Luís Torgo (2000); João Gama (2000); Rui Camacho (2000); Alneu Lopes (2001); Carlos Soares (2004); José da Silva Freitas (2007); Rui Leite (2008); Pedro Campos (2008); João Cordeiro (2011); Carla S. C. Gomes (2014); Mohammadreza Valizadeh (2014);[27] Salisu Abdulrahman (2017);[28] Luís Trigo (2018); Rui Sarmento (2020); Shamsuddeen H. Muhammad (2021);[29] Timóteo S. Muhongo (2021).

4.4 Ernesto Costa

Ernesto Costa completed Diplôme d'études supérieures in Computer Science at Pierre et Marie Curie University in Paris and a PhD in Electrical Engineering in Computer Science from the University of Coimbra (UC) in 1981, under the supervision of Yves Kodratoff [37].

He co-founded the Department of Informatics Engineering[30] of the Faculty of Science and Technology of UC in 1997, serving as its President in 1997-1999. He also served as President of the Scientific Council of UC from 2006 to 2008. He was instrumental in founding the Center for Informatics and Systems at UC (CISUC),[31] serving as its President in 1998-2000. He founded the Artificial Intelligence Group, which he directed until 2003, when he established the new group in Evolutionary and Complex Systems at CISUC.

He received the 2009 EvoStar Award for Extraordinary Contributions to the Field of Evolutionary Computing. Currently, he is a member of the Scientific Advisory Board of Complexica.[32] From 2012 to 2018, he was a member of the General Council of UC.

Ernesto is Emeritus Professor of the Department of Informatics Engineering, Faculty of Sciences and Technology of UC.

He was one of the authors of the book "Inteligência Artificial: fundamentos e aplicações" [38].

[26] http://www.liaad.up.pt
[27] Currently, Assistant Professor at the Faculty of Engineering of the University of Ilam in Iran.
[28] Currently, Professor at Kano University of Science and Technology in Wudil, Nigeria.
[29] Currently, Professor at Bayero University in Kano, Nigeria.
[30] https://www.uc.pt/en/fctuc/dei/
[31] https://www.cisuc.uc.pt/en
[32] https://www.complexica.com

Working Areas

Program Transformation [36]; Tutoring Systems [114]; Reasoning [18]; Genetic Algorithms [53]; Agents [82]; Learning; [20]; Evolutionary Computing [112]; Artificial Life [8]; Complex Systems [64]; and Computational Biology [45].

PhD Supervisions (and date of completion)

Nadia Azibi (1987), Amílcar Cardoso (1987), Francisco da Veiga (1994), Bernardete Ribeiro (1995), Carlos Bento (1996), José Luís Ferreira (1999), Francisco B. Pereira (2002), Maria João Loureiro (2002), Jorge Tavares (2007), Paulo Tomé (2007), Sara Silva (2008), Telmo Menezes (2009), Anabela Simões (2010), Tiago Baptista (2012), Nuno Lourenço (2015), Rui Lopes (2015), Leonor Melo (2018), João R. Campos (2022), João Macedo (2023), David Navega (2023), João Brás Simões (2024).

4.5 João Pavão Martins

João Pavão Martins obtained his PhD in AI from the State University of New York at Buffalo in 1983 [54] under the supervision of Stuart C. Shapiro. He played a key role in the development of SNePSLOG, a logic programming language similar to Prolog but with a different reasoning process [111].

Returning to Portugal, he joined the Mechanical Engineering Department at IST as Assistant Professor, teaching Programming courses.[33]

In 1984, he introduced AI at IST, establishing the AI Group, originally composed of a small number of master students in Electrical Engineering and undergraduate students in Mechanical Engineering. He co-taught the first AI courses in the Master's Degree in Electrical Engineering with Ernesto Morgado. Today, the original members of this group and their descendants constitute an important part of the work in AI that is developed at IST.

He co-founded the Degree in Computer Engineering (LEIC)[34] at IST in 1988, with an area of specialisation in AI, and co-founded the Department of Computer Engineering (DEI)[35] at IST in 1998, serving as its President during 2002-04 and 2009-10. He was responsible for the AI area at DEI.

In 1986, together with Ernesto Morgado, he founded SISCOG,[36] the first AI company in Portugal. SISCOG develops products and systems for resource planning and management in transportation companies, serving major railway and subway companies in Europe and North America, such as Dutch Railways, Norwegian Railways, Finnish Railways, VIA Rail Canada, Danish Railways, London Underground, among several others. The work at SISCOG has been recognised with three Innovative Application Awards by AAAI [70], [71], [63], [72].

João is Emeritus Professor of the Department of Computer Engineering at IST and Senior Member of AAAI.

He authored the AI book "Lógica e Raciocínio" [58], as well as several books on fundamentals of programming [55], [56], [57], [59], [60].

Working Areas

Belief Revision [62]; Non-monotonic Reasoning [40]; Knowledge Representation [49]; Reasoning [61]; Planning [104]; Ontologies [102]; Argumentation [109]; and Applications [72].

PhD Supervisions (and date of completion)

Carlos Pinto Ferreira (1991); Nuno Mamede (1992); Maria dos Remédios Cravo (1992); Sofia Pinto (2001); António Leitão (2001); Pedro Amaro de Matos (2003); Emanuel Santos (2012).

4.6 José Maia Neves

José Maia Neves (1948-2024) graduated in chemical engineering at UC and received his PhD degree in computer science at Heriot Watt University in Scotland [76]. He began teaching at UM in 1977, when the production engineering degree was established, with a branch in systems and information technology.

In 1983, he was one of the founders of the ALGORITMI Center,[37] a research unit at UM's School of Engineering. The center focuses on Industrial Electronics, Information, and Production Systems, with projects closely connected to the region's industry.

José was Emeritus Professor at the University of Minho.

He co-authored the book "Conflict Resolution and its Context: From the Analysis of Behavioural Patterns to Efficient Decision-Making" [19].

Working Areas

Computational Sustainability [5]; Evolutionary Computation [74]; Logic Programming [73]; Knowledge Representation and Reasoning [43]; Psychology and Economy [66]; The laws of thermodynamics [75]; Entropy [4].

PhD Supervisions (and date of completion)

Paulo Garrido (1995), Orlando Belo (1997), Rui Mendes (2000), Manuel Santos (2000), José Manuel Machado (2002), Paulo Sousa (2002), José António Tavares (2002), Paulo Ribeiro Cortez (2002), Víctor Alves (2002), Paulo Novais (2003), César Analide Rodrigues (2003), Miguel Pereira Rocha (2004), António Abelha (2004), Maria Goreti Marreiros (2008), Álvaro Moreira da Silva (2008), Ricardo Fernandes Costa (2009), Francisco Andrade (2009), Reus Salini (2012), Paulo Brandão (2013), Luís Mesquita Miranda (2013), Davide Carneiro (2013), José Alberto Marques (2013), Maria Bastos Salazar (2017), João Martins Ramos (2017), Tiago Martins Oliveira (2017), André Pimenta Ribeiro (2018), Bruno Marins Fernandes (2021), Filipa Ferraz (2022).

4.7 Eugénio Oliveira

After graduating in Electronic Engineering in 1972, Eugénio worked in Switzerland as an R&D Engineer at the Brown Bovery Electronics Lab (today, ABB).

In 1975, he was admitted as a Teaching Assistant at the University of Porto and, between 1980 and 1984, he was part of the AI group at UNL where he obtained the first PhD in AI in Portugal, under the supervision of Luís Moniz Pereira. In his thesis [78], he developed an expert system in Prolog, ORBI [95], for decision-making in the Biophysical Planning of the Territory, which was sold to the State Secretariat for the Environment. With this work, he received, together with Luís, the Gulbenkian Prize for Science and Technology.

Between 1984 and 1985, he was a guest academic at IBM's International Education Center in La Hulpe, Belgium, where VM Prolog was under testing, and also worked on tools for expert systems.

From 1983, Eugénio promoted the idea of Intelligent Robotics at the Faculty of Science and Technology of UNL, which ended up involving FEUP and the Faculty of Science and Technology of UC.

[33] At that time, there was no Computer Science Degree nor Computer Science Department at IST.

[34] https://fenix.tecnico.ulisboa.pt/cursos/leic-a

[35] https://dei.tecnico.ulisboa.pt

[36] https://www.siscog.pt/en-gb/

[37] https://www.di.uminho.pt/algoritmi.html

He participated in the UNIROB project, financed by JNICT.[38] As a result of this project, in 1986, the first robotic arm controlled by AI techniques was installed at FEUP.

In 1985, he created the AI Applications research line at the Center for Electrical Engineering at the University of Porto. Since 1986, he was professor of AI and Intelligent Robotics at FEUP, where he worked on the AI and Computer Science Lab (LIACC) coordinating the Research Group on Distributed AI and Agent-Based Simulation. He was part of LIACC's Coordination Council, of which he was director in 2008-09 and in 2011-2016. In 1986, he created the AI course in the Degree in Electrical and Computer Engineering at FEUP and two years later the AI and Intelligent Robotics Labs in the same department. At the University of Porto, together with Miguel Filgueiras, Luís Damas, and Pavel Brazdil, in1995, he launched the Master's program in AI and Computing,[39] followed by Master's in AI and Intelligent Systems. He designed the Doctoral Program in Computer Engineering, of which he was director from 2005 to 2018.

Eugénio is Emeritus Professor at FEUP. He belonged to the Scientific Council of the Gulbenkian Foundation for New Talents in AI.

Working Areas

Multi-agent Systems [79]; Natural Language Processing [44]; Software Agents' Emotions [77]; Trust and Reputation [81]; Intelligent Transportation Systems [21]; Distributed AI for industrial cyber-physical systems [103]; AI and Ethics [80].

PhD Supervisions (and date of completion)

Carlos Ramos (1993), Fernando Mouta (1996), Marcos Hochuli Shmeil (1999), Maria da Conceição Neves (2000), Maria Benedita Malheiro (2000), José Manuel Fonseca (2001), Ana Paula Rocha (2002), Luís Paulo Reis (2003), Luís Martins Nunes (2006), Andreia Malucelli (2006), Luís Morais Sarmento (2010), Henrique Lopes Cardoso (2011), Daniel Castro Silva (2011), Raul Ramos Pollan (2011), Célia Oliveira Gonçalves (2013), Maria Joana Urbano (2013), António Monteiro de Castro (2013), António do Nascimento Morais (2013), Pedro Ferreira Alves Nogueira (2016), Gustavo Alexandre Teixeira Laboreiro (2018), Nelson Martins Rodrigues (2019), Mohamed Yassine Zarouk (2020).

4.8 António Porto

António Porto obtained his PhD in 1984 at UNL, under the supervision of Luís Moniz Pereira [105]. He was a member of the Faculty of Science and Technology of UNL until 2008, being Vice-President in 1998-05. In 2008 he moved to the Faculty of Sciences of the University of Porto (FCUP), where he is Full Professor.

One of his important contributions was the development of a complete academic management system for UNL, still in daily use today. In this system there is a vision of total declarative integration, through specialised sub-languages, within an architecture of themes, channels, services, authentications, authorizations, and parametric styles. A particularly useful development was a new technology for defining a database schema and interacting with the corresponding database at a much higher level than SQL, approaching natural language.

Stimulated by real needs for large-scale development, António redesigned Prolog into an alternative language called Cube, with simpler and more efficient composition semantics and better high order features.

Taking advantage of the knowledge acquired with the design and implementation of UNL's academic management system, in 2007, with some collaborators, he launched a spin-off company, SQIMI[40], aiming at the agile development and support of integrated information systems.

Working area

Logic Programming [106].

PhD Supervisions (and date of completion)

Cristina Alves Ribeiro (1994); Gabriel Torcato David (1994); Artur Vieira Dias (1999).

4.9 Miguel Filgueiras

Miguel Filgueiras is retired Full Professor at the Department of Computer Science at FCUP. He obtained his PhD in 1984 at UNL under Luís Moniz Pereira [19]. He was one of the founders of the AI and Computer Science Lab (LIACC)[41] at the University of Porto.

In 1985, together with Luís Damas and Armando Matos he cofounded the Informatics Degree[42] in FCUP. In 1996, he co-founded the Department of Computer Science and the degree in Computer Science[43] at FCUP. Since then, the department has diversified its offer, at bachelor's, master's and PhD levels, in Computer Science.

Working Areas

Natural Language [46]; Logic Programming [107]; and Constraints [47].

PhD Supervisions (and date of completion)

Ana Paula Tomás (1997).

4.10 Luís Damas

Luís Damas is retired Associate Professor at the Department of Computer Science at FCUP. He obtained his PhD at the University of Edinburgh, in 1984, under the supervision of Robin Milner (1934-2010). Returning to Portugal, he was part of the Mathematics Group at FCUP.

In 1985, together with Miguel Filgueiras and Armando Matos he created the degree in Computer Science in FCUP. In 1996, he was co-founder of the Department of Computer Science.

In 1991, as Director of the Informatics Center at the UP, he collaborated with José Legatheaux Martins in proposing a project to the FCCN Program (Foundation for the Development of National Means of Scientific Calculation) to connect Portugal to the Internet .

In 2007, together with João Gama, João Mendes Moreira, and Luís Moreira-Matias, he founded Geolink,[44] as a spin-off of the Department of Computer Science of FCUP, in the area of vehicle communications and geographic databases. Geolink specializes in optimising the operation of car fleets, involving mobile computing devices that communicate in real time with central servers that permanently monitor and optimize vehicle operation. Geolink was actively involved in the Carnegie Mellon-Portugal program in the DRIVE-IN (Distributed Routing and Infotainment through VEhicular Inter-Networking) project, implementing an inter-vehicle communication network across the entire city of Porto. The work done at Geolink received "The George N. Saridis Best Transactions Paper Award for Outstanding Research" by IEEE [67].

Working Areas

Constraints [41]; Logic Programming [39]; Data Science [67]; and Learning [68].

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[38] National Board of Scientific Research and Technology.

[39] https://fe.up.pt/estudar/mia/?lang=en

[40] https://sqimi.com

[41] https://liacc.fe.up.pt

[42] Initially, Degree in Applied Mathematics (Computer Science branch).

[43] https://fe.up.pt/estudar/cursos/licenciatura-engenharia-informatica/

[44] https://www.geolink.pt

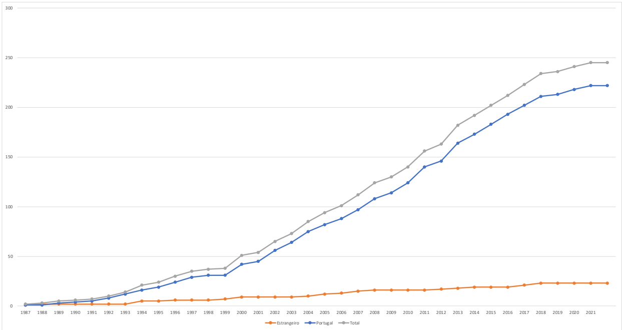

Figure 2. Total number of PhDs in AI (1987-21).

PhD Supervisions (and date of completion)

Nelma Moreira (1997); António Marcos Florido (1998); Michel Paiva Ferreira (2002).

4.11 Ernesto Morgado

Ernesto Morgado had an initial career similar to João Pavão Martins, completing the PhD in 1986 at the State University of NY at Buffalo, under the supervision of Stuart C. Shapiro [69].

He is a retired Associate Professor at IST. Over the years he was responsible for several undergraduate and master's courses. He was co-founder and coordinator of the AI branch at LEIC and co-founder of the Department of Computer Engineering at IST.

He belonged to the board of directors of the Portuguese AI Association (APPIA), was a member of the organising committee of the First Advanced AI School (EAIA 88) and a member of the organising committee of the Fourth Portuguese AI Conference (EPIA 89).

Together with João Pavão Martins, he founded SISCOG in 1986. The work carried out at SISCOG received three times the Innovative Application Award by AAAI [70], [71], [63], [72].

Working Areas

AI Applications [108]; SAT [65]; and Data Science.

PhD Supervisions (and date of completion)

Ricardo Saldanha (2003);[45] Fausto Almeida (2006).[46]

5 The New Generation

From 1987, a new generation of AI researchers emerged, some guided by the pioneers, others, coming from abroad. The new generation finds universities with computer science degrees receptive to teaching AI and some research groups already formed, where they fit in, creating their own space. PhDs oriented in Portugal began to emerge, reducing the PhDs completed abroad (Figure 2). Conferences and summer schools organised by APPIA allow the exchange of ideas and enthusiasm for new researchers. Email and Internet provide researchers with a means of communication and collaboration that was unimaginable when AI took its first steps in Portugal. The growing number of conferences and scientific journals on AI allows them to disseminate their work internationally.

From my analysis, in 2022, I identified a total of 245 PhDs in AI completed in the period 1987-21, out of which 222 completed their PhD in Portugal. Figure 3 compares the number of PhDs in Portuguese institutions. The work in Portugal begins, linked to Prolog and logic programming, and this topic is still quite evident in national research groups. With the evolution of AI, new areas are emerging and are embraced by national researchers. Figure 4 shows the most popular areas in the national arena. To produce it, I followed the approach that as long as a researcher had at least one publication in a field, I considered him/her to be working in that field. Agents stands out as the most popular with more than 50% of researchers working in this area,[47] followed by learning and data analysis.[48]

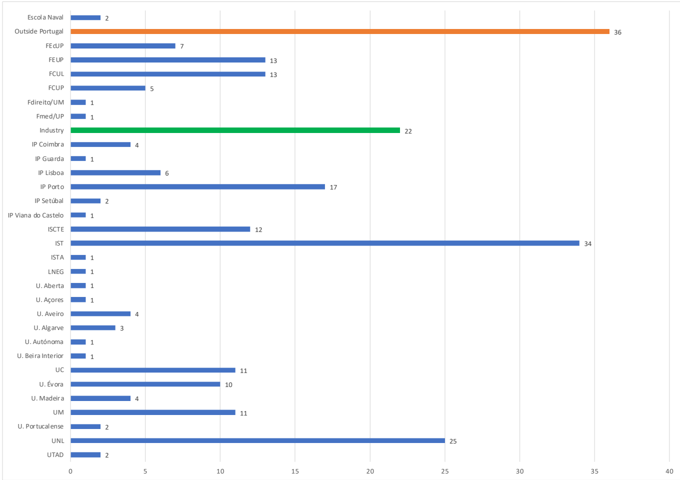

Figure 3. Number of PhDs by institution (1987-2021).

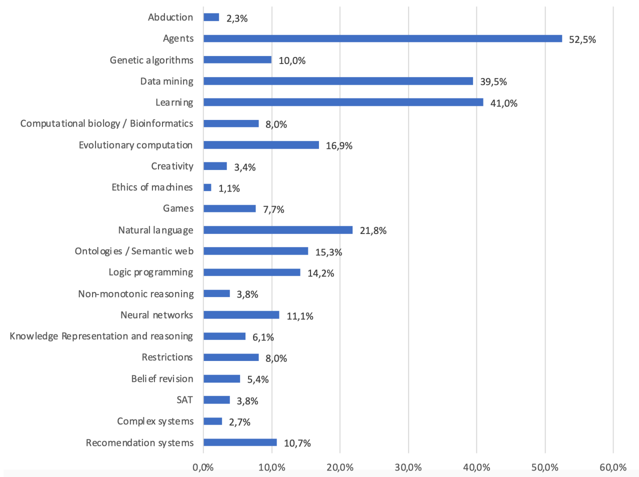

Figure 4. Most popular areas of work in Portugal.

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[45] Currently, working at SISCOG.

[46] *Ibid.*

[47] Agents includes agents, multi-agents, affective computing and other agent-related topics. If a researcher works on several of these topics, he was only counted once.

[48] In this area, *data mining* and *data science* were combined.

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Spanish Association for Artificial Intelligence: history, achievements and challenges

Felisa Verdejo[a], Francisco Garijo[b], Federico Barber[c], Antonio Bahamonde[d], Amparo Alonso[e], Luis Magdalena[f] and Alicia Troncoso[g,*]

[a]Universidad Nacional de Educación a Distancia
[b]Telefónica I+D
[c]Universitat Politècnica de València
[d]Universidad de Oviedo
[e]Universidade da Coruña
[f]Universidad Politécnica de Madrid
[g]Universidad Pablo de Olavide
ORCID (Felisa Verdejo): https://orcid.org/0000-0003-1457-4251, ORCID (Federico Barber): https://orcid.org/0000-0002-3966-5742, ORCID (Antonio Bahamonde): https://orcid.org/0000-0002-2188-9035, ORCID (Amparo Alonso): https://orcid.org/0000-0003-0950-0012, ORCID (Luis Magdalena): https://orcid.org/0000-0001-7639-8906, ORCID (Alicia Troncoso): https://orcid.org/0000-0002-9801-7999

Abstract. This year marks the first forty years of the Spanish Association for Artificial Intelligence (AEPIA), forty years of continuous progress along the path of Artificial Intelligence. In 1984 a group of pioneering researchers, led by Professor José Cuena, founder and first president of AEPIA, saw the need to unite the entire scientific and professional community to raise awareness of AI. Since that distant 1984 until today, many generations have contributed to the history of AEPIA building an association with many achievements and many challenges still ahead. This paper describes how the association was born, who the relevant people were, and what achievements have been made over these forty years. Our main objective is for all generations to come to know the long history and strength of our association.

1 Introduction

In the early years, a lot of work was done for Artificial Intelligence (AI) to be recognised within the field of computer science. Today, it is an achieved goal, and AI is now a highly recognised discipline. In those years, given the limitation of the existing media, the dissemination of activities throughout Spain was complex, however, that did not prevent the organisation of technical conferences being the embryo of one of our icons: the Conference of the Spanish Association for Artificial Intelligence. In addition, AEPIA has also promoted the creation of two international scientific journals. In AEPIA our young researchers have always been important and, therefore, many of our activities are aimed at these new generations, especially the Summer School.

The possibilities of AI to boost innovation have increased the interest of companies and governments around the world, obviously including the European Union. This interest has led to a high demand for professionals trained in Artificial Intelligence, a demand to which AEPIA has responded with the creation of an official Master's degree in Artificial Intelligence research. AI is experiencing its greatest splendour with significant media attention. However, this is the consequence of the degree of maturity it has reached thanks to the intense activity of Artificial Intelligence research groups.

Since its inception, AEPIA has been very proactive and dynamic. In this paper, we intend to show the history of AEPIA: the early years, the evolution, and the main events that marked its development. We will pay special attention to the achievements in these four decades: the scientific publications through AEPIA journals, the biennial CAEPIA conferences, the institutional and international presence, and the training work in AI through the EVIA Summer School and the Master's degree in Artificial Intelligence.

2 Birth of AEPIA

A group of Spanish researchers, working in various fields of Artificial Intelligence, met in Karlsruhe (Germany) in August 1983, during the International Joint Conference on Artificial Intelligence (IJCAI 1983) [2]. At that time, an AI association was being developed at European level, and this group of pioneering researchers considered necessary to also create it at Spanish level, to promote communication between AI researchers in Spain and to have a representation in the association that was being developed at European level.

In the fall of 1983, the researchers Mr. José Cuena, Mr. Francisco Garijo, and Ms. Felisa Verdejo led the initiative to contact academic and industry professionals to promote the creation of an association. They also sought sponsors for the organisation of a conference, obtaining sponsorship from the Foundation for the Development of the Social Function of Communications (Fundesco). On July 2, 3 and 4, 1984, the technical conference was held in the premises of the Telefónica satellite tracking station in Buitrago, with the aim of analysing the situation of Artificial Intelligence in Spain, as well as address-

* Corresponding Author. Email: atrolor@upo.es.

ing the creation of the Spanish Association for Artificial Intelligence (AEPIA).

The conference was attended by a total of forty participants from academia, business and government. The following research areas were represented: Expert Systems, Natural Language Understanding, Knowledge Representation and Acquisition, Robotics, Computer Vision, and Programming Environments for AI. The contents of the conference were compiled in the book "Inteligencia Artificial. Introducción y situación en España", published by FUNDESCO [10], representing an overview of AI research in Spain at that time. The conference ended with a session dedicated to the creation of AEPIA, in which a draft of statutes was approved and a management committee was appointed to complete those statutes and formalise the official procedures.

This management committee was formed by Ms. Carme Torras, Mr. José Cuena, Ms. Felisa Verdejo and Mr. Francisco Casacuberta, representing the four AI research centres that were identified at that time: Barcelona, Madrid, Basque Country and Valencia. The Spanish Association for Artificial Intelligence (AEPIA) was officially registered at the Ministry of Interior on August 31, 1984. And just a week later, AEPIA was accepted as a Spanish member of the European Committee for Coordination of Artificial Intelligence (ECCAI), which was held in Pisa from 5 to 7 September 1984 [8].

In 2023 a renewal of the statutes is carried out to adapt them to the reality of AEPIA and the current context of AI, which are approved in the General Assembly held on July 3, 2023 [7].

3 Organization of AEPIA

3.1 First Board of Directors

The first Board of Directors of AEPIA took office from 1984 to 1988 and was formed by Mr. José Cuena from Universidad Politécnica de Madrid as President, Ms. Felisa Verdejo from Universidad del País Vasco as Vice-President and Ms. Carme Torras from Universitat Politècnica de Catalunya as Secretary.

The Boards of Directors of all previous periods up to the present were formed by the following researchers.

- 1988-1992: President: Mr. José Cuena (Universidad Politécnica de Madrid), Vice President: Mr. Ramón López de Mántaras (Consejo Superior de Investigaciones Científicas), Secretary: Mr. Emilio Falceto (Corporación HISPAMER)
- 1992-2001: President: Mr. Francisco J. Garijo (Telefónica I+D), Vice-President: Mr. José Luis Becerril (Universidad Autónoma de Madrid), Secretary: Mr. Ángel Viña (Universidad Politécnica de Madrid)
- 2001-2007: President: Mr. Federico Barber (Universitat Politècnica de València), Vice-President: Ms. Ana M. García Serrano (Universidad Politécnica de Madrid), Secretary: Ms. Eva Onaindía (Universitat Politècnica de València).
- 2007-2013: President: Mr. Antonio Bahamonde (Universidad de Oviedo), Vice-President: Ms. Ana M. García Serrano (Universidad Politécnica de Madrid), Secretary: Mr. Óscar Luaces (Universidad de Oviedo).
- 2013-2021: President: Ms. Amparo Alonso (Universidade da Coruña), Secretary: Mr. Óscar Fontela (2013-2018, Universidade da Coruña), Ms. Verónica Bolón (2019-2021, Universidade da Coruña).

In the first periods of AEPIA, the Board of Directors consisted of four members representing the Basque Country, Catalonia, Madrid and Barcelona. In 1993 the Board of Directors was enlarged with representatives from the autonomous communities of Andalusia, Galicia, Asturias and Extremadura. From that moment on, the next Boards of Directors were expanded with the objective of having a member representing the largest number of autonomous communities.

In the current period (2024 -) the Board of Directors is formed by Ms. Alicia Troncoso Lora from Universidad Pablo de Olavide as President, Mr. Luis Magdalena from Universidad Politécnica de Madrid as Vice-President, and Mr. José C. Riquelme from Universidad de Sevilla as Secretary.

3.2 Evolution: Partners, financing, and web

In 1985, AEPIA began with approximately 150 members, and a very intense effort was made to recruit more members, reaching 315 members in 2001: 11 institutional members, 216 regular members, and 28 student members. Currently, AEPIA has 547 members: 10 institutional, 453 regular and 84 students.

Initially, the full membership fee was set at 3500 pesetas (21 euros), the student fee at 1500 pesetas (9 euros) and the institutional fee at 35000 pesetas (210 euros). In 1993, with the support of Telefónica I+D to house the headquarters of the AEPIA secretariat and an increase in dues, the financial situation of AEPIA was strengthened. Dues were set at 4000 pesetas (24 euros) for full members, 2000 pesetas (12 euros) for students, and an institutional fee of 40,000 pesetas (240 euros).

At the 2003 Assembly of members, taking place at the AEPIA conference (CAEPIA), an increase in dues was approved, with the regular fee being 30 euros, the student fee 15 euros, and the institutional fee 300 euros. After more than 20 years, AEPIA maintains these same amounts, being its main financial sources the fees, the CAEPIA congress and the Master of Research in AI.

In 1999 AEPIA launched its first website hosted at the Universitat Politècnica de València, but it is not until 2002 when the domain aepia.org was registered and AEPIA's own website is created in order to disseminate the activities. This website is maintained until 2021, and in 2022 a total technological renew of the AEPIA website is made: mail server, hosting, web and logo. A new mail server is contracted with greater storage capacity and new hosting with greater flexibility, a new logo is designed, respecting the essence of the previous logo, incorporating a more modern colour palette and a vectorised image, and a new more functional website is designed with current web technologies, which also incorporates forms to encourage the participation of members, who can register their research groups or apply for membership in the AEPIA: www.aepia.org.

4 AEPIA Conference: Birth of CAEPIA

The AI conference organised in Buitrago in 1984 was the embryo of our current Conference of the Spanish Association for Artificial Intelligence (CAEPIA). From 1985 onwards, one of the main activities of AEPIA was the organisation, every two years, of these conferences, which included both academic and professional activities. From 1985 to 1991 the conferences were held in Madrid. The I Jornadas Técnicas de IA (1985) and the II Jornadas (1987) were held at the premises of Universidad Politécnica de Madrid with a format of presentation of papers and a round table. The abstracts of the papers were published in the Association's bulletins. The III Technical Conference (1989), held at the Ministry of Industry and Energy in Madrid, was a national conference format with a program committee and peer review. The published proceedings included 27 papers and 10 abstracts corresponding to ongoing projects presented by companies.

The IV Technical Conference (1991) is held at the Consejo Superior de Investigaciones Científicas in Madrid, consolidating the national conference format initiated at the 1989 conference and renamed the AEPIA Conference (CAEPIA 1991). CAEPIA 93 continues to be organised in Madrid within the framework of SIMO (Salón de la Informática y el Material de Oficina) where joint AI dissemination activities are held. From then on, it was decided to organise the conferences outside of Madrid, including a Technology Transfer section, called TTIA. CAEPIA95 and TTIA95 were held jointly in Alicante. The following CAEPIA97 and TTIA97 conferences were held in Torremolinos (Malaga). CAEPIA97 included for the first time an invited conference as a recognition of AEPIA to the research work of one of its members, a recognition that is still maintained today.

CAEPIA99 and TTIA99 were held in Murcia and in CAEPIA99 the José Cuena Award was established for the best paper, an award that was maintained until 2007. From 1999, TTIA was no longer held separately. CAEPIA-TTIA 01 is held in Gijón, CAEPIA-TTIA 03 in San Sebastian, CAEPIA-TTIA 05 in Santiago de Compostela, CAEPIA-TTIA 07 in Salamanca, and CAEPIA-TTIA 09 in Seville. In the following editions of CAEPIA, TTIA will no longer be held.

The successive CAEPIAs that are held acquire more and more prestige as a scientific event, with contents (workshops, tutorials, presentations, demonstrations) and attendance that grow year after year. In CAEPIA 2007 a Doctoral Consortium is included for the first time, in which doctoral students present their thesis projects, obtaining a prize for the best-valued projects. CAEPIA 2015 holds, for the first time, a competition on AI applications in which the best-valued apps are awarded by an evaluation committee, and also in this same edition the Frances Allen award is incorporated, aimed at rewarding the best AI theses carried out by women. In 2018 a video competition is also added with the aim of promoting the dissemination of AI. All of these activities are continued today. In addition, in 2021 the Board of Directors of AEPIA approves that both (the apps and videos competition and the Doctoral Consortium) will be held annually within either CAEPIA or the Summer School as appropriate.

In the General Assembly of members held within CAEPIA 2011, the integration of CAEPIA in the Spanish Congress of Informatics (CEDI) was approved, being the celebration of CAEPIA 2013 for the first time within CEDI and with a multi-conference format, bringing together a wide variety of branches of Artificial Intelligence and with the assistance of many research groups from all over Spain.

The list of all CAEPIA editions is available in [3].

5 Publications

5.1 Iberoamerican Journal of Artificial Intelligence

As part of the dissemination work, AEPIA's management actively collaborated with different publishers to publish both books and special issues in relevant journals, involving the members of the association.

The first publication of AEPIA, created during the presidency of Mr. José Cuena, was a four-monthly bulletin that was distributed to the members by mail. The first issue of this bulletin, corresponding to the winter of 1985, included the following contents: Presentation, Newsletter, Bibliographic comments, List of members, International and National calendar. Subsequent bulletins also included the minutes of the assemblies and the papers of the technical conferences, and continued to be published regularly until the end of 1992. In autumn 1994, under the presidency of Mr. Francisco Garijo, a new 'Bulletin of AEPIA' was launched by Mr. Federico Barber, member of the Board of Directors. The booklet was published in Valencia, and the distribution to the members was made from Madrid and was financed by Telefónica I+D. In number 4 (Autumn '95) the publication was formalised with an ISSN registration: 1135-6669. At the end of 1996, and in view of the increasing quality of the publication, it was decided to give it a name of greater impact, 'Inteligencia Artificial, Revista Iberoamericana de Inteligencia Artificial', registering it with ISSN: 1137-3601. Mr. Federico Barber was the founding editor of the journal from the first issue published in the winter of 1997 until 2001. This first issue had a new design, developed by Juan Carlos Carril from the design team of Telefónica I+D. The cover of the journal was changed again in December 2003, with a single-colour design by Mr. Youn Shin Cho to facilitate printing. At the 1999 General Assembly, it was decided to increase the promotion of the journal and to create its own electronic portal, which Beatriz Barros and her team at UNED made a reality in 2000, registering the digital version with the ISNN 1988-3064. The portal, successively updated under the Open Journal System (OJS) platform, has evolved to its current version, which facilitates the management process, evaluation, and free download of publications. During the presidency of Mr. Federico Barber (2001-2007), the journal was promoted by new editors: from issue 16, Ms. Ana García Serrano from Universidad Politécnica de Madrid. The scientific section was headed, first by Ms. Camino Rodríguez Vela from Universidad de Oviedo and later by Mr. Lawrence Mandow from Universidad de Málaga. Thanks to the dedication and effort of successive editors, the content has been improved and consolidated as a means of disseminating the work of the AI research community. It is the first journal in which scientific articles on Artificial Intelligence can be published in Spanish, Portuguese, and English.

The journal was distributed in printed form regularly to members during this period and was one of the main tangible benefits of belonging to AEPIA.

In 2010, following a certain trend in the publication of scientific journals, the journal was published only in electronic format, with the printed version on request.

In the AEPIA Assembly held within the CAEPIA 2011, the transfer of the journal to the Iberoamerican Society of Artificial Intelligence (IBERAMIA) was approved by assent, being now the journal financed and edited by IBERAMIA.

After a period of interim, from 2012, Ms. Ana García Serrano from Universidad Nacional de Educación a Distancia took over again the edition of the journal, until 2015. Then, Miguel A. Salido, from Universitat Politècnica de València, took over these tasks, being its current editor. Currently, the journal is referenced in various indexes and databases, both national and international (Scopus, Web of Science, DOAJ, Google Scholar, Latintdex, ROAD, etc.). The journal maintains its Open Access character (OJS platform), at no cost to authors or readers [9].

5.2 Progress in Artificial Intelligence Journal

In the Ordinary General Assembly held within CAEPIA 2009, the elections for the Presidency of AEPIA were held and Mr. Antonio Bahamonde was elected as President. During this period, AEPIA worked on the creation of a new journal called Progress in Artificial Intelligence (PRAI), published online by Springer and supported by AEPIA and the Portuguese association APPIA. This journal was founded with the aim of publishing high-level research results in all aspects of Artificial Intelligence, from fundamentals to applications, describing the latest research and developments. The journal has as its first Editor-in-Chief Mr. Francisco Herrera from Universidad de Granada. After a great effort, the journal finally published its first issue in March 2012. The intense dedication of the editorial team for many years has made the journal indexed in bibliographic reference databases such as SCOPUS, Google Scholar, DBLP, or ACM Digital Library, among others [11].

In 2021, Mr. Sebastián Ventura from Universidad de Córdoba and Ms. Mª José del Jesus from Universidad de Jaén took the position of Editors-in-Chief.

6 International Conference of AEPIA: the birth of IBERAMIA

During the first years, AEPIA carried out intense dissemination work to make the association known to the national and international research community.

In the international field, contacts with Mexico were established, which crystallised in the 'I Encuentro Hispano-Mexicano en Inteligencia Artificial', which was held from 14 to 16 May 1986 in Mexico City. AEPIA was represented by Mr. J. Agustí, Mr. José Cuena and Ms. Felisa Verdejo. This meeting, attended by 21 Mexican researchers, played for them a similar role to the AEPIA Technical Conferences in Buitrago, creating the Mexican Artificial Intelligence Association (SMIA), whose first president was the researcher Mr. José Negrete.

To promote international collaboration, one of the initiatives carried out was the organisation of an Ibero-American Congress on Artificial Intelligence (IBERAMIA), whose first call was published in the AEPIA Bulletin of Winter 87. Thus, the first IBERAMIA congress was born, sponsored by the Fira de Barcelona, and co-organised by the Spanish, Mexican, and Portuguese AI associations. IBERAMIA 88 was held on January 11, 12 and 13, 1988 in Barcelona, and 22 papers and 19 posters were presented and collected in a publication.

The organisation of the initial IBERAMIA congresses was carried out by a committee formed by representatives of the national AI associations that supported IBERAMIA. The committee was initially formed by representatives of AEPIA (Spain), SMIA (Mexico), and APPIA (Portugal), and later was joined by AVIA (Venezuela) and a Cuban representative. The committee selected the venue and organisers, delegating in them the responsibility for the organisation: program committee, local organising committee, publications, finance, etc.

To unify the criteria and ensure the selection process of papers through a format similar to other scientific organisations, it was decided within IBERAMIA 96, held in Cholula (Mexico), to create a secretariat to coordinate the process of deciding new venues, unify criteria, and serve as a historical memory to facilitate organisational processes. This headquarters was assigned to AEPIA and was located in Telefónica I+D until the foundation of the Iberoamerican Society of AI (IBERAMIA) on March 14, 2009, being its promoter partners Mr. Francisco J. Garijo and Mr. Federico Barber (previous presidents of AEPIA) and Mr. Antonio Bahamonde and Mr. Óscar Luaces (president and secretary of AEPIA at that date, respectively).

During those first years, AEPIA participated very actively in collaboration and coordination with all the Iberoamerican partners in the organisation of the IBERAMIA conferences, whose first edition was held in Barcelona in 1988. It was also involved in the organization of other workshops associated with the conference, such as the Iberoamerican Workshop on Distributed AI and MultiAgent Systems, whose second edition was held in Toledo in 1998.

All current information on IBERAMIA is available in [4].

7 International relations

During the early years of AEPIA, it cooperated at the European level with other national AI societies, such as AFIA (France) and APPIA (Portugal), and especially with the European Association of Artificial Intelligence (EurAI, formerly called ECCAI).

Since 1984, when AEPIA became a member of EurAI, it has been involved in its organisation, being part of its Board of Directors. In particular, Mr. José Cuena was Secretary of the EurAI Board from 1992 to 1996, Mr. Ramón López de Mántaras, Vice-President of AEPIA, was a member of the EurAI Board from 1988 to 1992, and Mr. Ulises Cortés, member of the AEPIA Board is elected member of the EurAI Board from 2021 to 2024.

AEPIA has also promoted the visibility of Spanish AI research at the international level, participating in the EurAI European Congress on Artificial Intelligence (ECAI) and in the EurAI journal (AI Communications). Mr. José Cuena gave the invited plenary lecture at ECAI 1996, ECAI 2004 was held in Valencia, being Mr. Vicent Botti the president of the organising committee, and Mr. Ramón López de Mántaras, member of AEPIA until 1994, was editor chair of the journal from 92 to 94.

In the following years, several members of AEPIA have been distinguished as EurAI Fellows: Ms. Felisa Verdejo (2002), Mr. Lluis Godo (2006), Ms. Carme Torras (2007), Mr. Pedro Meseguer (2008), Mr. Francisco Herrera (2009), Mr. Serafín Moral (2011), Mr. Pedro Larrañaga (2012), Mr. David Pearce (2014), Mr. Vicente Botti (2017), Ms. Nuria Oliver (2018), and Mr. José Hernández Orallo (2021). The list of all award winners can be consulted in [1].

The candidacy of Santiago de Compostela was chosen for the celebration of ECAI 2020, which was held online due to the COVID pandemic, and therefore was chosen again for the celebration of ECAI 2024, being the local chairs Mr. Senén Barro, Mr. José María Alonso, and Mr. Alberto Bugarín, member of the Board of Directors of AEPIA.

In the field of computer science, AEPIA joined coordinating structures of international scientific-technical societies, such as the International Federation for Information Processing (IFIP), in which Mr. José Cuena was appointed Spanish representative in the Technical Committee 12 (Artificial Intelligence), organising in Madrid the IFIP TC12 Workshop on Artificial Intelligence from the Information Processing Perspective in 1992.

8 Relations with other institutions

In the early days, multiple initiatives were also developed for AEPIA to be present in the activities of other societies in different fields. Some of them are the organisation of a course on Artificial Intelligence and Medicine with the College of Medical Doctors in 1985, the organization of a course on expert systems (sponsored by IBM) with the Spanish Association of Informatics and Automatics (AEIA), the organization of a round table on AI Research and Education at SIMO in 1986, the organization of sessions on AI at general conferences, such as the Iberian Convention of Computer Scientists (CIBI) held in conjunction with SIMO.

Since 1985, Spanish groups have been able to participate as full partners in the calls of the Framework Programme and other specialised programmes, so AEPIA encouraged contacts and collaborations with CDTI (Centro para el Desarrollo Tecnológico y la Innovación), FECYT (Fundación Española para la Ciencia y la Tecnología) and representatives of other ministries, to promote and advise the participation of Spanish groups, both academic and business, in European programs. Since then and until now, the relationship between AEPIA and CDTI is very close, participating in numerous CDTI events as well as jointly organising events, such as the Infoday on Artificial Intelligence held on June 16, 2021.

In 2005, during the celebration of CEDI (Conferencia Espaola de Informática), the creation of a scientific society that would federate the main scientific societies and associations related to Informatics began to take shape, with the aim of representing this group, promoting its achievements, and defending its interests. It was not until 2009 when the Sociedad Científica de Informática de España (SCIE) was created, with AEPIA being one of the founding societies, as stated in the minutes of the General Assembly of members held at CAEPIA 2009.

Since AEPIA became a member of SCIE in 2009, it has been involved in its organisation, being part of its Board of Directors, participating in its main congress (CEDI), integrating CAEPIA within it every four years, and supporting nominations for the National Computer Science Awards, convened by SCIE and from 2016 by SCIE and the BBVA Foundation. In turn, Mr. Antonio Bahamonde, a member of AEPIA, assumes the vice-presidency of SCIE from 2012 to 2016 and the presidency of SCIE in the period 2016-2020.

In the national computer science awards, the following members of AEPIA have been distinguished: Mr. José Mira Mira (José García Santesmases 2009 award), Mr. Francisco Herrera (Aritmel 2010 award), Mr. Enrique Vidal (Aritmel 2011 award), Mr. Pedro Larrañaga Múgica (Aritmel 2013 award), Mr. Óscar Cordón García (Aritmel 2014 award), Ms. Felisa Verdejo (José García Santesmases 2014 award), Ms. Asunción Gómez Pérez (Aritmel 2015 award), Ms. Nuria Oliver (Ángela Ruiz Robles 2016 award), Ms. Vicente Botti (José García Santesmases 2018 award), Mr. Senén Barro (José García Santesmases Award 2020), Mr. Eneko Aguirre (Aritmel Award 2020), Mr. Antonio Bahamonde (José García Santesmases Award 2021), Mr. Francisco Casacuberta (José García Santesmases Award 2022).

In October 2003 the Confederation of Scientific Societies of Spain (COSCE) was constituted with the participation of 42 scientific societies, including AEPIA. Since then, AEPIA has been part of COSCE, being proactive since its beginnings, in which Ms. Felisa Verdejo was Vice President of COSCE from 2009-2013. Currently, Ms. Amparo Alonso, as president of AEPIA, has participated in the round table on the impact of AI at the COSCE Societies Conference in 2021 and Ms. Alicia Troncoso, as president of AEPIA, at a round table on ethics of AI at the COSCE Societies Conference in 2023.

In 2020 AEPIA signs an agreement with the Society for Statistics and Operations Research (SEIO) to encourage the participation of members of both societies in the respective activities organised by each association, also establishing a reduced fee.

Regarding relations with the Ministry in charge of AI, the objective of AEPIA is to achieve a relevant role as an official interlocutor. In October 2020, the Advisory Council for Digital Transformation is constituted as a collegiate body that will advise the Ministry of Economic Affairs and Digital Transformation in the design of the proposal of the Government's policies on digital transformation, and AEPIA is invited to be part of this Council. In June 2022, the Spanish-language PERTE (Strategic Projects for Economic Recovery and Transformation) Advisory Council is created, with AEPIA forming part of this Council.

9 Training for young researchers

9.1 *Summer School of Artificial Intelligence: Birth of EVIA*

In the Assembly of members held in CAEPIA 2013, under the presidency of Mr. Antonio Bahamonde, an initiative is proposed for the implementation of a Summer School. As a result, the AEPIA Summer School, called EVIA, was born, being its first edition held in La Coruña in 2014. The second edition was held in Carmona (Seville) in 2016. Both editions included activities having students playing the main role, such as the Doctoral Consortium, prizes for the best PhD Dissertation, Final Degree Project competition, Master's Final Project competition, etc.

In order to enrich EVIA, the third edition held in Santiago de Compostela in 2017 included presentations by international researchers, and the fourth edition was organised jointly with the Portuguese association APPIA, which is an international school and is also interdisciplinary, including speakers from other disciplines. In 2021 the AEPIA Board of Directors proposes to hold the videos and apps on an annual basis in conjunction with EVIA or CAEPIA as appropriate. In addition to the videos and apps, the annual Doctoral Consortium is proposed, as well as a prize for the best thesis. Thus, the fifth edition of EVIA is held in Seville in 2023 including all these activities to consolidate the event. All activities are described in [5].

9.2 *Master in Artificial Intelligence Research*

During 2015 a committee appointed by AEPIA is working on the development of a syllabus for an online master's degree in Artificial Intelligence in Spanish. This committee is led by Mr. Antonio Bahamonde from Universidad de Oviedo as president, and five members: Ms. Eva Onaindía (Universitat Politècnica de València), Mr. Alberto Bugarín (Universidade de Santiago de Compostela), Mr. Óscar Corcho (Universidad Politécnica de Madrid), Ms. Alicia Troncoso (Universidad Pablo de Olavide), Mr. Enrique Alba (Universidad de Málaga). The first edition of the Master's program will be launched in the 2016-2017 academic year, offering 60 places for students. The Master is 100% online, gives access to PhD, and has three intesifications: Learning and Data Science, Web Intelligence, and Reasoning and Planning. The faculty is made up of senior professors from different Spanish universities and teaching assistants who support the tasks of tutoring and evaluating students.

The master's degree is taught on the PoliformaT platform of Universitat Politècnica de València and is currently in very high demand. All the information can be found in [6].

10 Conclusions

In the mid 80's it would probably be difficult to imagine that forty years later Artificial Intelligence would become a constant news item in the world's media. With the modesty typical of its environment, AEPIA has worked hard but satisfactorily towards this recognition. Throughout these four decades, hundreds of researchers and professionals have achieved that Spanish Artificial Intelligence has a relevance above expectations. The achievements of AEPIA are patent, and many of its members are researchers of recognised prestige. With these lines, we express our gratitude to those who paved the way and allowed us to build a solid foundation for further progress. It is the new generations, the repositories of this work, who will allow AEPIA to continue to be one of the spearheads of technology in Spain.

The challenges we will face in the coming years are numerous. Whenever humanity has advanced technologically, there is always a negative effect of a certain mistrust.

Artificial Intelligence cannot be reversed, but it must face a deficit of trust in society. For this, at least two premises must be fulfilled: the first is that it must be explained, that is, it must be understood, because knowing how something works generates calm; the second is that its use must be regulated, and it must be reliable and ethical. Its use to generate fraud, create bias, or infringe on our privacy must be prosecuted by new laws.

Once these premises are overcome, the future is impressive, the increase in productivity, and the generation of new advances in all fields of knowledge will have a fundamental impact on our lives in a few years. The applications of Artificial Intelligence in areas such as health, agriculture, industry, leisure, education, human welfare, energy, etc. will make it possible to offer us a longer and higher quality life, turn climate change around, and achieve a more sustainable, advanced, and fairer society. To achieve this, “only” three factors are needed: qualified professionals, quality data, and adequate computational infrastructures. In all of them we are sure that AEPIA will contribute its two cents.

Acknowledgements

We thank all the presidents of AEPIA for their invaluable help in recovering the history of AEPIA described in this paper.

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A Short History of the Early Years of Artificial Intelligence at Edinburgh

Christopher K. I. Williams[a,*], **Vassilis Galanos**[b] **and Xiao Yang**[a]

[a]School of Informatics, University of Edinburgh
[b]Lecturer in Digital Work, University of Stirling
ORCID (Christopher K. I. Williams): https://orcid.org/0000-0002-6270-4703, ORCID (Vassilis Galanos): https://orcid.org/0000-0002-8363-4855, ORCID (Xiao Yang): https://orcid.org/0000-0003-4389-6495

This paper provides a brief overview of the the academic structures developed for Artificial Intelligence (AI) research at the University of Edinburgh in the 1960s and 1970s, and some highlights of the ground-breaking work carried out.

1 Structures and Chronology

We give a short overview of the various structures in the University of Edinburgh that were developed to accommodate AI research in Edinburgh, based heavily on Jim Howe's document [10].

The start of AI research at Edinburgh can be traced back to a small research group established at 4 Hope Park Square in 1963 under the leadership of Donald Michie. In 1965 this became the Experimental Programming Unit with Michie as Director. In 1966 the Department of Machine Intelligence and Perception (DMIP) was formed, funded by a large Science Research Council (SRC) grant held by Donald Michie, Christopher Longuet-Higgins and Richard Gregory. The latter two had left Cambridge to come to Edinburgh. Michie's main interests were in design principles for the construction of intelligent robots, whereas Gregory and Longuet-Higgins were interested in using computational modelling of human cognitive processes to provide insights into their nature. Longuet-Higgins' research group was called the Theoretical Section, and Gregory's the Bionics Research Laboratory. Bernard Meltzer had also set up the Metamathematics Unit in the mid 1960s to pursue research in automated reasoning. At this time Edinburgh was one of the few centres in the world working on AI, along with Stanford, MIT and CMU. Michie, Longuet-Higgins, Gregory and Meltzer may be regarded as some of the "founding fathers" of AI.

In 1969 Longuet-Higgins founded the School of Epistemics, an interdisciplinary group which brought together people with an interest in the mind. Longuet-Higgins defined epistemics as "the construction of formal models of the processes - perceptual, intellectual, and linguistic - by which knowledge and understanding are achieved and communicated". When Longuet-Higgins left in 1974, Barry Richards of the Department of Philosophy became the Director of the School.

There were some structural re-organizations in the early 1970s, leading finally to the formation of the Department of Artificial Intelligence (DAI) in 1974. Its first head was Meltzer, who stepped down in 1977 and was replaced by Jim Howe, who led it until 1996. A separate unit, the Machine Intelligence Research Unit, was set up in 1974 to accommodate Michie's work. In 1983 Michie co-founded the Turing Institute in Glasgow.

Part of DAI's role was to be involved in undergraduate teaching, and the staff developed courses for this. The material was published in a book [4], one of the first undergraduate AI courses in the world.

The years after the Lighthill report (1973) [13] were a lean time for AI in the UK, and by 1979 DAI had only four members of academic staff. However, the Alvey initiative (1983, the UK response to the Japanese 5th Generation Project) allowed a rapid expansion in staffing. In 1985 the School of Epistemics became the Centre for Cognitive Science within the Faculty of Science, devoted exclusively to research and postgraduate teaching. This became the base for Edinburgh's future strength in natural language processing.

2 Research highlights

This section briefly describes work on reinforcement learning, robotics, programming, automated reasoning, natural language processing, computer-based learning environments, and cognitive science carried out in Edinburgh. The selection of material is based largely on Alan Bundy's talk from 2023 [3].

Reinforcement Learning: The Matchbox Educable Noughts And Crosses Engine (MENACE) [15] was a very early example of reinforcement learning. It played a game of noughts-and-crosses (or tic-tac-toe). It took the first turn, and then alternated turns against a human player. Depending on whether the machine won, drew or lost a game, it obtained positive or negative reinforcement for the sequence of moves it made. MENACE was able to successfully learn how to perform well on the game. It is interesting that the learning algorithm was actually implemented at first using a matchbox for each state, due to a lack of access to a digital computer.

Robotics: Freddy (1969–1971) and Freddy II (1973–1976) were experimental robots built in Edinburgh. Freddy II was a "hand-eye" robot that could assemble toy wooden models from a heap of pieces. It used vision to identify and locate the parts, and was able to rearrange them to enable identification when they were obscured by other parts [1]. Given the state-of-the-art at the time, this required not only building the robot, but also designing and building the vision system, and a programming environment for controlling the various subsystems. The team involved with Freddy included Patricia ("Pat") Ambler, Harry Barrow, Chris Brown, Rod Burstall, Gregan

* Corresponding Author. Email: C.K.I.Williams@ed.ac.uk

Crawford, Donald Michie, Robin Popplestone, Stephen Salter[1], and Ken Turner.

Later work by members of the team developed RAPT [17], providing a higher-level specification for robot behaviour at the object level, rather than low-level actuator programming. Freddy II has been on display at the National Museum of Scotland since 2006.

Programming: The programming language POP-2 [6] was designed and developed by Robin Popplestone and Rod Burstall. It supported much subsequent UK research and teaching in AI. Later, Warren et al. [20] developed a Prolog compiler for the DECsystem-10 (written in Prolog). This robust implementation paved the way for the widespread use of Prolog.

Automated Reasoning: Meltzer assembled a stellar group of researchers in automated reasoning, including Robert Boyer, Alan Bundy, Patrick Hayes, Robert Kowalski, J. Strother Moore and Gordon Plotkin. Kowalski & Kuehner's 1971 paper [12] studied "Linear resolution with selection function" (aka SL-resolution) as an inference system for first-order logic. A restricted version of SL-resolution forms the basis for Prolog. Boyer and Moore [2]'s work on proving theorems about LISP functions was notable for its automation of induction.

Bundy et al. [5] developed the largest Prolog program of the time called MECHO to solve high-school level mechanics problems specified in predicate calculus and English. Notably MECHO used meta-level inference to control search in natural language understanding, common sense inference, model formation and algebraic manipulation.

Natural Language Processing: Thorne et al. [19] was a groundbreaking development in the syntactic analysis of sentences, using an augmented transition network (ATN). This work was an important precursor to William Woods' famous ATN parser [22].

Going beyond parsing, language exists to enable communication between agents. Davey [7] built a program to generate a description of a small model universe, specifically the moves in a game of noughts-and-crosses, which it played with its operator. The key problem addressed was to generate explanatory commentaries, referring to entities and moves in terms of their strategic significance in the game, a precursor to modern work in "explanatory AI". The work was supervised by Christopher Longuet-Higgins and Stephen Isard.

Power [18] built a program where two robots hold a conversation in order to accomplish a mutual goal, in a world of few objects. The robots could carry out several types of exchange, such as agreeing plans, or obtaining information. The idea behind having a robot-robot interaction was to avoid a human guiding the structure of the dialogue, as they often do in a human-robot conversation.

Computer-based learning environments: At MIT Papert [16] had developed learning environment to enable a child to communicate with a device called a "turtle" via a program written in LOGO. This was to investigate his view that a child learns by actively exploring their environment. In Edinburgh Jim Howe set up a laboratory to investigate these ideas, working with, *inter alia*, Ben du Boulay, Tim O'Shea and Sylvia Weir. See Howe and O'Shea [11] for an evaluation of the effects of LOGO programming on learning a number of mathematical topics, and Emanuel and Weir [8] for a study of how controlling the LOGO turtle helped the development of language for communication in an autistic child.

Cognitive Science: Longuet-Higgins' group worked on topics across a wide range of areas. The associative net of Willshaw et al. [21] was an early neural network model which learned to associate input-output pairs of patterns with a Hebbian learning rule. Longuet-Higgins was a fine musician, and worked on topics such as the computational representation and analysis of harmony and metre in music (see, e.g., Longuet-Higgins and Steedman [14]). He also had interests in vision, and e.g. supervised Geoffrey Hinton's PhD thesis [9] on how the best consistent combination from among many parts or aspects of visual input may be obtained by constraint relaxation.

More resources about the history of AI in Edinburgh can be found at https://groups.inf.ed.ac.uk/aics_history/.

[1] Later famous for his work on wave power.

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Four figures of Parisian AI research and four questions to ask them

François Pachet[a,*,1] **and Jean-François Perrot**[b,1]

[a]No affiliation
[b]LIP6, Sorbonne-Université

Abstract. In this paper, we attempt to restore part of the particular atmosphere that reigned in Parisian AI laboratories during the 1970s-1990s, *i.e*. from the arrival of personal computers until the birth of the internet. During this period, AI experienced a second winter, but paradoxically the ideas that were developed, notably thanks to the researchers we are talking about here, were extremely rich and influenced many AI researchers still active today. These four researchers, Patrick Greussay, Jean-Louis Laurière, Jacques Pitrat and Jean-Claude Simon, developed bold and complementary ideas. Thus, Greussay worked on programming languages, the essential tool (it was thought) for building AI systems. Simon was interested in the production of symbols from signals, particularly through handwriting recognition. Laurière made essential contributions to so-called symbolic AI, which can be seen as the production of symbols from other symbols. Pitrat developed original ideas on the architecture of AI systems, and the need, according to him, to build reflective systems, able to manipulate representations of themselves and their own knowledge. We ask each of them a question linked to his work which seems relevant to us.

1 Introduction

The dazzling successes of artificial intelligence, particularly Deep Learning, have eclipsed a whole bunch of previous work and original research that it seems appropriate today not to forget. Paradoxically, the main exponents of Deep Learning themselves regularly implore young researchers to come up with other ideas than those followed by the most popular models of the day (the large language models, at the time of writing this article). Here we propose to briefly retrace the visions of four particularly important researchers on the Parisian AI scene, whose work is today somewhat forgotten and deserves to be re-examined. The geographical proximity of these people made it possible to create numerous bridges between their ideas (and their teams), notably at the LAFORIA laboratory [6]. In a way, they have contributed to defining a "French Touch" of AI in a bygone but fertile era for the evolution of ideas on the nature and modeling of human intelligence. Lastly, In those times, AI was a branch of so-called Cognitive Sciences, as much as a branch of Computer Science. Following a constructivist approach, heavily influenced by Papert and Minsky, building systems was a means of investigating possibly ill-posed problems. Consequently, researchers often chose their object of study mostly because it was considered interesting *per se* . This is to be compared with the current situation, where general-purpose systems are "tuned" for direct use in industry.

* Corresponding Author. Email: pachet@gmail.com.
[1] Equal contribution.

2 Patrick Greussay

Patrick Greussay (1944-), musician and programmer, worked from 1969 in the computer science department of the Centre universitaire expérimental de Vincennes, later University of Paris-VIII-Vincennes. He co-founded the Art and Computers Group of Vincennes (GAIV [17]), bringing together visual artists, architects, musicians, and engineers, which brought artificial intelligence into European artistic practices [16]. Greussay wanted to equip himself with tools that did not exist in France at his time. He carried out an implementation of Lisp on small machines (*VLisp*, "the Lisp of Vincennes, the fastest interpreter in the world", it was said) which played a considerable role in France; he explored the so-called "AI languages" (Plasma, Planner, Conniver) up to Smalltalk and object-oriented programming. Programs were supposed to imitate human thought processes, and languages had to make it easy. The great virtue of Lisp, according to him, was to "keep imagination intact". He played a key role in the thesis supervision of many French computer scientists, notably Pierre Cointe, who initiated work on the reflexivity of object-based languages [12]. The programmers and musicians of the GAIV played a major role in the creation of IRCAM (Acoustic/music research and coordination institute). However, it is today no longer obvious that engineers need programming languages at all. Programming itself seems threatened as an activity, with advances in automatic programming or no-code [1].

Question: Do we still need specific programming languages for AI at a time when AI seems to make languages useless?

3 Jean-Louis Laurière

Jean-Louis Laurière (1945-2005) [7] was a professor at the Pierre and Marie Curie University and he strongly influenced French research in so-called symbolic AI. His work, notably the *Alice* system (to solve combinatorial problems) and then the *Snark* system (to write inference rules for expert systems, which were in great fashion at that time), were pioneers in their fields. *Alice* [13] contains revolutionary ideas for the time, some of which are still relevant. One of *Alice*'s boldest ideas was to combine two representations of the same combinatorial problem, both in symbolic form (the constraints as they are expressed, in the form of equations or inequalities) and in the form of a graph, allowing in particular to perform intelligent filtering, in order to reduce the search space. Although constraint programming is often credited to Alain Colmerauer (yet another important French figure of AI) and the logic programming school, we consider the work of Laurière, with Mackworth [18], the primary ancestor of constraint programming, at least for the filtering dimension. Indeed today, most constraint satisfaction solvers and libraries have gotten rid of the logic programming layer. His charismatic personality and outspokenness appealed to a whole generation of students and convinced them to work on knowledge representation.

Question: Is the inference problem solved? Why do we no longer talk about complexity (P versus NP)?

4 Jacques Pitrat

Jacques Pitrat (1934-2019) [9] is considered one of the founding fathers of French AI. His long career has accompanied the evolution of AI since the beginning (programmatic AI, where we thought we could solve problems using algorithms) with notable work on chess games [19] as well as the unification algorithms so useful to Prolog. However, his major contribution was to take an early interest in the reflective capacities of artificial intelligence systems, and to highlight the need to build a system truly capable of learning by itself, of knowing itself, in order to produce and manipulate meta-knowledge. Superviser of Laurière's Ph.D., he was deeply impressed by his vision - he has for example produced numerous reflexive reformulations of the *Alice* system. His latest work focused on the creation of an artificial researcher in artificial intelligence [20]. This theme which, at the time, could seem iconoclastic and unrealistic is today taken quite seriously [14, 11].

Question: is meta-knowledge soluble in the architecture (for example so-called auto-regressive networks?) How can a modern AI system be provided with the capacity for introspection other than by reifying its own meta-knowledge?

5 Jean-Claude Simon

Jean-Claude Simon (1923-2000) [10] was mainly interested in shape recognition, and in particular handwriting recognition. He cofounded one of the first companies dedicated to this issue, A2IA [5], which still exists today. He was also one of the main players in the university master IARFAG that trained most of the French AI researchers of that time. In an interview broadcast on radio *France Culture* in 1971, he described, using non-technical vocabulary, the architecture of a shape recognition system capable of identifying handwritten characters. It is striking, in this interview, that the main ideas of today's convolutional systems (developed in particular by Yann Lecun, a former student of J.-C. Simon [15]) seem already there. In particular the Gestalt-inspired idea of reducing an image to its primitive components, then recomposing them in a hierarchy of parts to eventually come up with an informed decision (which letter is written). A vision that took 40 years to materialize! Today, when the analysis of images and signals of all kinds reaches performances that were once unimaginable, surpassing those of humans, we'd like to ask him:

Question: have we gotten everything we can from signal analysis? Is pattern recognition still a relevant area of research?

6 Conclusion

This article aims to shed light on four French researchers who had considerable influence on the AI of their time. In a way, they were already aiming at achieving a kind of artificial general intelligence. They followed a reductionist method: each one focusing on his own domain.

The spectacular advances in deep learning technologies have had the side effect of obscuring a whole series of concerns (notably the end of specialized domains of AI), some of which are still relevant today. Of course, we would love these researchers to answer our questions (and many others!) regarding the impact and continuation of their work. Perhaps thanks to AI, it will be possible one day to know their answers.

Acknowledgements

The National Audiovisual Institute (INA), the largest audiovisual archive center in the world, organizes monthly seminars [8] during which a scientist talks about his field through the filter of INA archives. On this occasion, the first author proposed in 2023 a history of AI through a selection of archives [2, 3], during which he discovered fascinating documents on the pioneers of the AI French scene [4].

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European research contributions to model-based reasoning – a personal view

Franz Wotawa[a,*]

[a]Graz University of Technology, Institute of Software Technology, Graz, Austria
ORCID (Franz Wotawa): https://orcid.org/0000-0002-0462-2283

Abstract. Model-based reasoning has been a very active and important area of artificial intelligence research utilizing logic and other formal approaches for detecting and identifying faults in all kinds of systems ranging from ordinary hardware to even software. European researchers have always been very active in this research community. The objective of this paper is to outline these activities. Hence, we present the basic foundations and contributions of European researchers to the theory and practice of model-based reasoning and discuss some application areas of particular interest.

1 Introduction

Automation of certain tasks like scheduling, configuration, or diagnosis is of great practical interest for increasing efficiency and reducing costs. In the literature, many papers have utilized different techniques and algorithms. In this paper, we focus on model-based reasoning as the foundation behind solving such tasks and, in particular, present the most important works originating from European researchers in this domain. Although the basic concepts and ideas come from the U.S. and Canada, i.e., [16, 15, 18] and [71, 19], there have been substantial contributions from European researchers to this field worth being discussed over more than 30 years.

The objective of this paper is to show the main contributions to model-based reasoning from Europe, giving a historical perspective. The content presents a personal view of the authors and may be incomplete. Instead of presenting contributions considering a timeline, we discuss the papers categorized by modeling, algorithms, and application areas. In addition, we discuss the underlying foundations and use examples to make the paper more easily accessible.

To illustrate the basic ideas behind model-based reasoning, we use the two-bulb electric circuit comprising a battery B, a switch S, and two bulbs L_1, L_2. Figure 1 depicts the circuit. When switching on S, we expect both bulbs to transmit light. If this is not the case, we are interested in finding a cause. For example, when both bulbs are not lighting after switching on S, we would expect either two broken bulbs or an empty battery. In the former case, we have an explanation comprising two components, whereas in the latter, we only require one component to explain the unexpected behavior.

In contrast to other previous work on diagnosis, which mainly relies on explicitly representing diagnostic knowledge in the form of rules, model-based reasoning, and model-based diagnosis, in particular, rely on structure and behavior models of a system. Whereas classical rule-based systems, e.g., [5, 44, 72, 45], state knowledge used

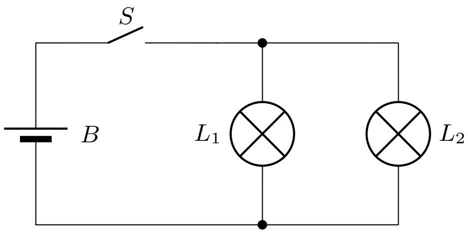

Figure 1. A simple electric circuit comprising bulbs, a switch, and a battery.

to infer root causes in the form "symptom $\rightarrow$ cause", model-based systems revert this rule and a diagnosis algorithm selects causes such that all symptoms can be explained. Causes are represented by assumptions of the health condition of components, e.g., $\neg ab$ stating that a component is not abnormal, i.e., working as expected, or $s0$ stating that the output of a digital gate is stuck at false regardless of its input. Hence, the models explicitly capture knowledge of how components work under different assumptions, as well as the structure of the whole system.

It is worth noting that rule-based systems, i.e., expert systems, have been successfully used in industry. However, they also have some issues which cause higher maintenance costs. This includes the requirement to change substantial parts of the rule set for each system and also for each system change, which is not the case for model-based reasoning, where component models can be used in arbitrary systems without changes. Hence, model-based reasoning can be seen as an answer to the problem of higher maintenance costs of rule-based systems. Moreover, stating the behavior of components can be considered easier than coming up with rules from symptoms to causes.

We structure the paper as follows. We start outlining the basic definitions of model-based reasoning using the two-bulb circuit as an illustrative example. Afterward, we discuss the main contributions of European researchers in this field, focusing on modeling, algorithms, and application areas. Finally, we give an overview of current European research in this field and conclude the paper.

2 Basic foundations

In this section, we briefly outline the different methodologies of model-based diagnosis and use the two-bulbs example from Figure 1 to illustrate the concepts. For more information and more recent papers introducing model-based diagnosis, we refer the inter-

* Corresponding Author. Email: wotawa@ist.tugraz.at

ested reader to [97, 98].

We start discussing consistency-based diagnosis and follow – more or less – Reiter's basic definitions [71]. Note that in literature, consistency-based diagnosis is often referred to as model-based diagnosis. However, for clarity, we distinguish consistency-based diagnosis from abductive diagnosis in this paper.

For consistency-based diagnosis, we start defining a diagnosis system, which comprises a set of components and a system description.

Definition 1 (Diagnosis System)**.** *A tuple $(SD, COMP)$ is a diagnosis system where SD is a set of first-order logic sentences describing the structure of the system and the behavior of its components, and $COMP$ is a set of components.*

For our running example from Figure 1 the diagnosis system $2BC$ can be introduced as follows:

The components $COMP_{2BC} = \{b, s, l_1, l_2\}$ comprises the battery, the switch, and the two bulbs l_1 and l_2.

The system description SD_{2BC} can be formulated as follows:

$$\left\{\begin{array}{c} batt(B) \rightarrow (\neg ab(B) \rightarrow power(B, nom)) \\ switch(S) \rightarrow (\neg ab(S) \wedge on(S) \rightarrow (in(S,X) \leftrightarrow out(S,X))) \\ switch(S) \rightarrow (\neg ab(S) \wedge off(S) \rightarrow out(S, zero)) \\ bulb(L) \rightarrow (\neg ab(L) \wedge in(L, nom) \rightarrow light(L)) \\ bulb(L) \rightarrow (\neg ab(L) \wedge in(L, zero) \rightarrow \neg light(L)) \\ \\ batt(b) \wedge switch(s) \wedge bulb(l_1) \wedge bulb(l_2) \\ in(s,X) \leftrightarrow power(b,X) \\ out(s,X) \leftrightarrow in(l_1,X) \\ out(s,X) \leftrightarrow in(l_2,X) \\ \neg(in(C,nom) \wedge in(C,zero)) \\ \neg(out(C,nom) \wedge out(C,zero)) \end{array}\right\}$$

The first part describes the behavior of the components, i.e., the battery, if working, provides nominal power. If on, the switch transfers the available power from the input to its output. If it is off, then there is no power at the output. If the bulb is working and has nominal power on its input, it will produce light. Otherwise, there is no light. The final part of the system description introduces the components and their interconnections.

When having certain information like the switch is pressed, but no bulb is lightning, we are interested in the causes behind this unexpected behavior. In consistency-based diagnosis, we set the values of the $\neg ab$ predicates defined for components in a way such that no inconsistency arises. Formally, a diagnosis can be defined as follows:

Definition 2 (Diagnosis)**.** *Let $(SD, COMP, OBS)$ be a diagnosis problem comprising a diagnosis system $(SD, COMP)$ and a set of observations OBS. A set $\Delta \subseteq COMP$ is a diagnosis if and only if $SD \cup OBS \cup \{ab(C)|C \in \Delta\} \cup \{\neg ab(C)|C \in COMP \setminus \Delta\}$ is satisfiable, i.e., is not inconsistent.*

For example, let us assume the observations $OBS = \{on(s), \neg light(l_1), \neg light(l_2)\}$. When assuming all components to be healthy, i.e., working correctly, SD_{2BC} together with OBS would lead to an inconsistency. However, when assuming the battery b does not work, i.e., $\Delta = \{b\}$, we cannot derive an inconsistency again. The same happens when setting Δ to $\{l_1, l_2\}$.

Computing diagnoses can, in the simplest case, be done by selecting an arbitrary subset of $COMP$ and checking for inconsistency. Reiter [71] suggested to use hitting sets from conflicts, which are defined as follows:

Definition 3 (Conflict)**.** *Let $(SD, COMP, OBS)$ be a diagnosis problem. A set $CO \subseteq COMP$ is a conflict if and only if $SD \cup OBS \cup \{\neg ab(C)|C \in CO\}$ is unsatisfiable, i.e., inconsistent.*

Note that theorem provers often can easily return conflicts. However, more recently, other approaches to working without requiring conflicts have been introduced. It is further worth noting that Greiner et al. [36] corrected Reiter's hitting set algorithm.

The second diagnosis methodology is abductive diagnosis, which was mainly driven by European researchers. Friedrich et al. [27] introduced the concepts and ideas behind abductive diagnosis. Substantial contributions also come from Torasso et al., e.g., [92].

We start defining abductive diagnosis, considering a corresponding diagnosis system.

Definition 4 (Abductive diagnosis system)**.** *A pair (SD, HYP) is an abductive diagnosis system where SD is a logical model, and HYP is a finite set of hypotheses.*

The idea behind abductive reasoning is to search for hypotheses such that we are able to derive given observations. Hence, a model SD for the two-bulb example would look like follows:

$$\left\{\begin{array}{c} batt(B) \rightarrow (empty(B) \rightarrow power(B, zero)) \\ batt(B) \rightarrow (ok(B) \rightarrow power(B, nom)) \\ switch(S) \rightarrow (on(S) \wedge broken(S) \rightarrow out(S, zero)) \\ switch(S) \rightarrow (on(S) \wedge ok(S) \rightarrow out(S,X) \leftrightarrow in(S,X)) \\ switch(S) \rightarrow (off(S) \wedge ok(S) \rightarrow out(S, zero)) \\ bulb(L) \rightarrow (broken(L) \rightarrow \neg light(L)) \\ bulb(L) \rightarrow (ok(L) \wedge in(L, nom) \rightarrow light(L)) \\ bulb(L) \rightarrow (ok(L) \wedge in(L, zero) \rightarrow \neg light(L)) \\ \\ batt(b) \wedge switch(s) \wedge bulb(l_1) \wedge bulb(l_2) \\ in(s,X) \leftrightarrow power(b,X) \\ out(s,X) \leftrightarrow in(l_1,X) \\ out(s,X) \leftrightarrow in(l_2,X) \end{array}\right\}$$

$HYP = \{empty(b), ok(b), broken(s), ok(s), broken(l_1), ok(l_1), broken(l_2), ok(l_2)\}$

Note that in this model, we capture the correct and the incorrect behavior. Moreover, we allow rules that are not in horn clause form. In the original article by Friedrich et al., the authors rely on horn clauses and the formulation of faulty behavior.

We are now able to define abductive diagnosis as follows:

Definition 5 (Abductive diagnosis)**.** *Given an abductive diagnosis problem (SD, HYP, OBS) where (SD, HYP) is an abductive diagnosis system (SD, HYP) and OBS is a set of observations. A set $\Delta \subseteq HYP$ is a diagnosis if and only if*

1. *$SD \cup \Delta \models OBS$, and*
2. *$SD \cup \Delta$ is satisfiable, i.e., $SD \cup \Delta \not\models \bot$.*

An abductive diagnosis for the observation $OBS = \{\neg light(l_1), \neg light(l_2)\}$ considering that $on(s)$ is element of SD is, for example, $\{ok(b), ok(s), broken(l_1), broken(l_2)\}$. Another one is $\{empty(b), ok(s), ok(l_1), ok(l_2)\}$. In both cases, the observations can be derived.

Note that abductive diagnosis and consistency-based diagnosis have similarities and can be formally brought together. Console and Torasso [8, 9] provided the foundations basically stating that introducing modeling faulty behavior in consistency-based diagnosis allows for computing the same diagnoses as abductive reasoning, and vice versa (see [7]).

After discussing the basic foundations, where European researchers fundamentally contributed to at least a part, i.e., abductive diagnosis, we give an overview of other contributions in the next section.

3 Contributions

We categorize the contributions into three parts, i.e., modeling, algorithms, and applications. In all these parts, we can report substantial contributions to the body of knowledge in model-based reasoning.

3.1 Modeling

Modeling for model-based diagnosis is not a simple task, which may be one reason for the not-so-widespread use of model-based diagnosis in applications. The quality of models determines the diagnosis capabilities, and therefore, coming up with the right models for particular systems is of uttermost importance. This is well visible considering the model used for consistency-based diagnosis of the two-bulb circuit (from Figure 1) introduced in Section 2. Let us take the model SD_{2BC} to provide diagnoses for the set of observations $OBS' = \{\neg light(l_1), light(l_2), on(s)\}$, i.e., where one bulb is lightning but the other is not. A valid diagnosis would be $\{l_1\}$ but another one $\{b\}$. The latter diagnosis is not expected. In case of an empty battery, we would expect both bulbs not to emit light. The reason for this wrong diagnosis is that we cannot derive the necessity of available power in case a bulb is lightning.

Struss and Dressler [84] identified this problem and provided a solution. In particular, the authors suggested introducing fault modes with their corresponding models. For this example, adding a rule $batt(B) \rightarrow (ab(B) \rightarrow power(B, zero))$ would solve the problem because it would allow us to state that power is available from which we can derive an inconsistency. However, this solution leads to a higher computational complexity. Hence, Friedrich and colleagues [28] suggested formalizing physical impossibilities and adding them to the system description SD. For the particular case of the two-bulbs example, we would only need to add $\neg(\neg light(l_1) \wedge light(l_2))$ and $\neg(light(l_1) \wedge \neg light(l_2))$ to SD, which does not increase the overall computational complexity.

Besides the work on improving modeling with the objective of avoiding the computation of unexpected diagnoses, there have been substantial contributions to the use of abstraction for modeling. Obviously, the models used are not necessarily capturing the real physical behavior of components and systems. On the contrary, we want to have models that are abstract enough to guarantee a faster computation of diagnosis but not compromise the quality of diagnosis, i.e., not being able to distinguish different important diagnoses or not coming up with more or less potential root causes. Early work in this direction includes [33, 82] and [61]. The latter considers constructing models hierarchically to improve the overall diagnosis time. It is worth noting that the ideas have been used also by colleagues [2] who came up with a formalized theory. The use of structural properties, like hierarchies of models, has also been applied for diagnosing knowledge bases (see [21]).

Sachenbacher and Struss [74, 75] presented a more general theory of abstraction for diagnosis aiming at finding abstractions of the data domain such that diagnoses can be still distinguished.

Another area of modeling where European researchers have provided a lot of activities and papers includes the use of finite automata and similar concepts for diagnosis. First work include [52]. Rozé and Cordier [73] presented an approach for diagnosing discrete event systems. Grastien and colleagues [35] continued this work and provided an incremental diagnosis approach. Other work in going in this direction include [67, 37, 47, 48, 49, 50, 51].

Other papers deal with establishing relationships to other diagnosis methods, e.g., [12] or [13], consider other characterizations of models, e.g., diagnosability [66, 78, 34, 100, 3] or self-healability [14], and integrate repair into diagnosis [29, 26, 91, 24].

3.2 Algorithms

At the beginning of model-based diagnosis, and in particular consistency-based diagnosis, two algorithms have been considered. De Kleer and Williams [18] utilized truth maintenance systems like the ATMS [17] for diagnosis, where European researchers like Struss and colleagues [81, 85] have contributed their extensions and improvements. The other algorithms have been based on the hitting set computation from Reiter and colleagues [71, 36]. Improvements of hitting set algorithms were suggested by several European researchers, e.g., [93, 70, 23]. Fröhlichh and Nejdl [32] suggested another diagnosis algorithm and provided an experimental evaluation.

More recently, researchers have provided algorithms that utilize theorem provers directly for computing diagnoses without the need for hitting-set computations, e.g., [62, 25, 53]. Those algorithms perform very well, showing that the improvement of SAT solving helps enable its use in other areas like diagnosis. For a detailed comparison of several hitting sets and direct diagnosis algorithms, we refer to [63].

Another category of diagnosis algorithms exploits the use of structural knowledge for diagnosis. Based on the work of Fattah and Dechter [20] providing a diagnosis algorithm for tree-structured systems, Stumptner and Wotawa [87, 89] provided another algorithm for such systems. Moreover, the authors also considered the application and provided further information on how to integrate such algorithms for system diagnosis (see [90]). Later, Sachenbacher and Williams [76] showed that the algorithms of Fattah and Dechter and Stumptner and Wotawa can be generalized, considering diagnosis as a semiring-based constraint optimization problem.

3.3 Application areas

European researchers have been contributing to the application of model-based reasoning in several application areas. In the following, we summarize some contributions in particular areas. We start with *mobile and autonomous systems*. Early work includes onboard diagnosis for cars, e.g., [54, 55, 77, 6, 11]. To bring these approaches into practice, some authors also provided papers dealing with the development process and required adaptations, e.g., [60, 69]. For a summary of work dealing with the application of model-based diagnosis in the automotive domain, we refer to [86].

In autonomous systems, and in particular robotics, Hofbaur et al. [41] introduced the use of model-based diagnosis to implement a smart control for mobile robots in case of faults. Other work includes [80].

There has been a lot of work on utilizing model-based reasoning for *software debugging*, i.e., localizing faults in programs. Console et al. [10] provided the basic foundations showing that model-based reasoning improves debugging compared to alternative approaches. Friedrich et al. [30, 31] and colleagues, e.g., [95, 64, 65] applied this idea to debugging of hardware description language programs written in VHDL and Verilog. The authors provided different models ranging from simple data-driven to more complex constraint models. Stumptner and Wotawa [88] applied model-based diagnosis to functional programs and, together with colleagues, also to sequential and object-oriented programming languages like Java, e.g., [56, 58, 59, 99]. Later, the ideas have been applied to spreadsheets [1, 46] and knowledge-bases and ontologies [79, 22].

It is worth noting that there is also work on combining model-based reasoning models, e.g., [43], methods, e.g., [42], and also to establish connections to other debugging approaches like program mutations (see [94]) or program slicing [96]. The latter is particularly interesting because it shows that abstract models considering data dependencies provide the same solutions as static program slicing for debugging. Challenges like handling of loops utilizing program abstraction were also tackled [57].

A third important application domain is infrastructure and, in particular, *communication and other supply networks*. Several papers described the application of model-based reasoning for telecommunication systems, e.g., [73, 67]. For power supply networks, the early work of Stuss and others [4, 68, 91] is worth mentioning.

Finally, European researchers have applied model-based reasoning to solve *environmental issues*. Here we mention pioneering work by Heller and Struss [38, 39, 40]. Struss et al. [83] discussed the importance of model-based reasoning for the environmental domain.

4 Conclusions

This paper summarizes the contributions of European researchers working on foundations and the application of model-based reasoning. The content provides evidence that the European research community provided many new insights into the body of knowledge on model-based reasoning. It is worth noting that some application areas are dominated by European research in this field, e.g., software debugging. From the provided citations, the European pioneers in the area of model-based diagnosis can be easily identified, including Friedrich, Nejdl, and Gottlob from Austria, Struss and Dressler from Germany, Cordier, Dague from France, and Console, Torasso, and Dubrè from Italy to mention the one starting the research field in Europe.

The model-based reasoning field is still active, carrying out the International Workshop on Principles of Diagnosis, which will be converted into a conference in its next edition. It is worth noting that the description of contributions is personal and far from complete. This paper may serve as a reference point for further, more detailed research on the European history of model-based reasoning.

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Timeline of the History of Artificial Intelligence in Europe

Cristian Barrué[a] **and Ulises Cortés**[b,*]

[a]Institut de Robòtica i Informàtica Industrial, CSIC-UPC, Barcelona, Spain
[b]Universitat Politècnica de Catalunya & Barcelona Supercomputing Center, UPC-BSC, Barcelona, Spain

Abstract. As Artificial Intelligence and its applications continue to reshape our world, understanding its historical roots becomes increasingly crucial. This is particularly true for Europe, where a rich tapestry of AI-based research and innovation has unfolded over the last seven decades.

We hypothesise that by documenting the histories of Artificial Intelligence in Europe through this timeline, we will uncover underrepresented milestones, providing insights into future AI research directions and policy developments. This timeline will offer a comprehensive historical record and serve as a practical tool for analysing trends in Artificial Intelligence development specific to the European context. It will allow us to draw connections between historical advancements and the current landscape, guiding academic and industrial decision-making.

1 Introduction

As the pervasive influence of Artificial Intelligence (AI) and its applications continues to reshape our world, the need to comprehend its historical roots becomes increasingly urgent. This is particularly true for Europe, where a rich tapestry of AI-based research and innovation has unfolded over decades. The rich histories of AI in Europe have been underexplored in historical accounts if compared to the US and Japan. Recent publications such as Bibel (2014) and Sandewall (2014) have begun to address this gap by providing an overview of AI's early history in Europe [4],[5]. However, more focused accounts on regional development remain sparse. By integrating sources from European scientific journals, AI communications, and interviews with AI pioneers, we aim to provide a more robust citation base that will serve as a comprehensive reference for European AI history. In this paper, we strongly advocate for creating a comprehensive timeline that documents the rich history of AI in Europe (see 2). This invaluable resource will benefit researchers, policymakers, and industry leaders.

While global narratives of AI's history often focus on contributions from the United States and Japan, it is crucial to recognise that Europe has played a pivotal but underreported role in AI research and development, making significant contributions that have shaped the field. This timeline will fill a critical gap by documenting Europe's contributions, including breakthroughs in logic programming, cognitive architectures, and robotics, many of which have influenced global AI policy, innovation, and research. In doing so, we will address the gap in existing literature and provide a European-centric perspective, underscoring how Europe's regulatory, ethical, and academic frameworks shaped AI's trajectory differently from other regions. By critically evaluating the historical decisions and long-term impacts on Europe's AI landscape, influenced by key figures, we can extract valuable insights for future strategic planning.

Building a comprehensive timeline of AI history in Europe is important and crucial for understanding the continent's unique contributions and challenges in this rapidly evolving field. By highlighting significant historical landmarks, we can trace the development of AI across Europe and identify key turning points that have shaped the current landscape (see §2).

To ensure accuracy and breadth, it is essential to consult a diverse range of AI experts from various European countries, national AI associations, and institutions and gather their insights on pivotal milestones and influential figures (see Figure 2). This collaborative approach will help identify the key individuals who have played instrumental roles in advancing European AI, providing inspiration for future generations of researchers and practitioners.

To maintain consistency and relevance, we must develop a clear set of criteria and recommendations for including historical facts in the timeline, considering factors such as impact, innovation, and geographical representation (see §3).

Finally, we propose that the EurAI Board adopt these criteria and recommendations, leveraging its position as a leading organisation in the field to oversee and validate this important historical record, ensuring its ongoing accuracy and value to the European AI community (see §4.1).

2 The Timeline

In this timeline, we define 'European AI contributions' as milestones that either (a) originated from European research institutions or companies or (b) were led by European scientists on European soil, excluding those that were born in Europe but developed their AI contributions in the US or Japan. This definition ensures that we capture contributions from European researchers working internationally while strongly focusing on the European context. Furthermore, we will include major European-led AI conferences, projects funded by European bodies (such as the European Union), and European regulatory efforts that have influenced Artificial Intelligence research and development on a global scale.

This timeline (see [2]) aims to offer a more comprehensive overview of the development of Artificial Intelligence in Europe than previous attempts. We aim to help establish clear criteria for including events, individuals, scientific papers, and milestones in a timeline of European Artificial Intelligence history. For us, those criteria are necessary for several reasons:

- **Ensuring accuracy and relevance**: Clear criteria help the com-

* Corresponding Author. E-mail:ia@cs.upc.edu

munity to ensure that the timeline includes significant contributions and milestones specific to European AI development rather than just any AI-related events.
- **Enabling fair representation**: Criteria help ensure a balanced representation of contributions from different European countries, institutions, and time periods.
- **Enhancing educational value**: Understanding the criteria provides insight into what historically significant factors in European Artificial Intelligence development for students and researchers.
- **Enabling updates**: As Artificial Intelligence research and applications evolve, establishing criteria makes it easier to update the timeline with new developments consistently.
- **Avoiding bias:** Clear criteria can help mitigate potential *biases* in selection, ensuring a more objective representation of European Artificial Intelligence history.

Figure 1. WHAI

Therefore, by carefully defining these criteria, you create a more robust, useful, and insightful timeline that accurately reflects the unique journey of AI development in Europe [3].

2.1 A glance to the timeline

One of the key innovations of this timeline is its digital format, which allows for continuous updates and interactive features. Unlike static historical records, the timeline will be a living document accessible online, allowing users to explore AI milestones by decade, region, or specific subfields of AI. This dynamic approach ensures that the timeline remains relevant as new developments in AI unfold while providing an intuitive interface for researchers, students, and policymakers.

Figure 1 below showcases a sample mock-up of the timeline interface, designed to help readers better understand its structure. Each milestone is represented by a clickable node, allowing users to interact with individual events. Users can zoom in on specific periods for a more detailed view. At the top of the interface, a prominent visual of the selected milestone is displayed, accompanied by a detailed description and relevant media, such as images or documents. The timeline at the bottom is fully navigable and spans various decades, with clearly marked years for easy reference. Items are organised into distinct categories, displayed in horizontal rows:

- **People:** This section is dedicated to monitoring influential figures in the development of AI in Europe; see, for example, figure 2.
- **Milestone:** It highlights key events or breakthroughs, such as the publication of the ethics guidelines.
- **Paper:** This section highlights seminal scientific papers and influential publications with significant academic, industrial, or societal impact in the field of Artificial Intelligence. It showcases groundbreaking research from esteemed institutions such as the leading European universities, as well as pioneering work from industry leaders like DeepMind. These works have shaped the trajectory of AI in Europe, driving innovation, addressing ethical considerations, and influencing policy decisions across the globe.
- **Association:** This section is dedicated to capturing the associations of researchers in thematic, national, or transnational areas that have been important for organising and channelling research or industrial activities in the field of artificial intelligence in Europe.
- **Culture:** This section might focus on broader cultural or societal impacts of AI over time.

The timeline spans from ancient Greeks to the present days, showing past developments and potentially projecting future milestones, making it a living, evolving document that can be updated over time. The categorisation is still open to discussion. Further details on the validation process can be found in 3.1.

3 Criteria for inclusion: A first approach

To ensure the Artificial Intelligence timeline's accuracy, relevance, and comprehensiveness, we recommend discussing, among others, the following criteria for including historical facts and individuals:

- **Significance**: Events, discoveries, or publications that markedly advanced Artificial Intelligence theory or practice in Europe.
- **Innovation**: Include first-of-its-kind achievements or unique European contributions to global Artificial Intelligence development, research and applications.
- **Impact**: Developments that significantly influenced European or global Artificial Intelligence research, policy (*e.g.* [1]), or industry.
- **Cross-disciplinary Relevance**: AI advancements that bridged multiple fields or had broad societal implications.
- **Geographical Representation**: Ensuring representation of contributions from various European countries and regions.

The timeline's inclusion criteria selection is based on best practices from historical documentation and archival research methodologies. Significance, innovation, and impact are essential criteria used in previous Artificial Intelligence historical accounts [4],[5]. However, we add a focus on geographical representation to ensure we capture contributions from underrepresented European regions. By focusing on cross-disciplinary relevance, we acknowledge the integrative nature of AI research, which frequently draws from computer science, philosophy, and cognitive sciences. Thus, these criteria offer a balanced and comprehensive historical record highlighting widely known and lesser-known contributions.

3.1 Risks

Building a timeline is not easy, and some risks must be avoided. For example, (a) there is a risk of criteria favouring well-known institutions or regions, potentially overlooking significant contributions from less prominent sources; (b) It can result in challenging to *objectively* determine what qualifies as a *significant* milestone or contribution worthy of inclusion in the timeline; (c) dealing with incomplete information, historical records may be incomplete or *biased*, making it challenging to apply consistent criteria across different periods, and (d) ensuring transparency and explainability.

Not less important will be addressing potential disagreements among experts and adapting criteria to the ever-evolving definition of Artificial Intelligence. AI definition and scope have changed over the last seventy years, which can complicate the application of consistent criteria in the future.

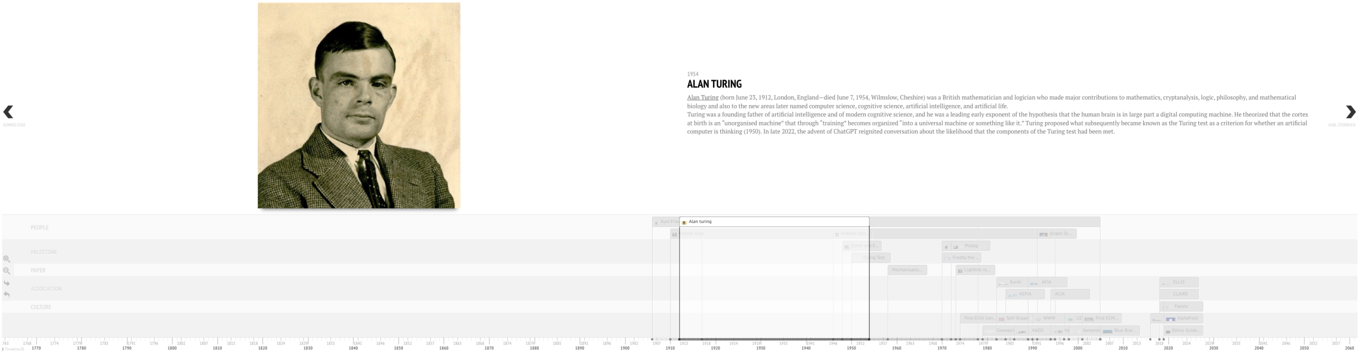

Figure 2. Timeline showcasing Alan Turing item

By carefully considering these potential risks, our community can develop a more comprehensive and accurate timeline for the history of Artificial Intelligence in Europe. This will enable us to better navigate the complex landscape of AI research and application developments, regulation, and implementation.

To address the potential risks inherent in constructing this timeline, we propose a multi-phase validation process that will take as a starting point the current timeline implementation [2].

First, a collaborative discussion will be held with the participants of the first Workshop on the History of AI in Europe, which will take place during the 50^{th} anniversary of ECAI. In this session, the categories of the timeline's different items and the inclusion criteria will be reconsidered. In a second step, a diverse committee of AI experts from various European countries and disciplines belonging to the EurAI Board will review and validate the results. This will ensure a more balanced representation of events across the continent. Furthermore, we will pursue a funding mechanism whereby historians and researchers can propose milestones that will undergo expert evaluation. This approach aims to mitigate potential *bias* and increase the transparency of the selection process.

This will be complemented by interviews with pioneering AI researchers in Europe, whose first-hand accounts will provide qualitative insights into the lesser-documented aspects of European AI history.

4 Conclusions and Future steps

The European Artificial Intelligence Strategy aims to make the EU a world-class hub for AI and ensure that Artificial Intelligence is human-centric and trustworthy.

The creation of this timeline is not merely an academic exercise; it has practical applications in education, policy, and industrial innovation. We believe that the timeline and our proposed criteria contribute to the European AI Strategy. The EurAI Board's pivotal role in adopting and overseeing these criteria will be instrumental in adding a layer of authority and credibility to the project. Their expertise and connections with AI experts across Europe and their validation of the timeline's content will be invaluable in creating a trusted historical record.

To further strengthen the timeline's historical significance, we propose an empirical analysis of the impact of selected AI milestones on subsequent research and industry development in Europe. This will be achieved by tracing citation networks from key European AI papers and patents, identifying how ideas and innovations have diffused through both academic and industrial domains. By quantifying the influence of European AI contributions in this way, we can demonstrate their long-term significance within the global AI ecosystem.

4.1 Recommendation for EurAI Board Adoption

We propose that the European Association for Artificial Intelligence (EurAI) Board adopt these criteria and recommendations for creating and maintaining the European AI timeline. As a leading organisation in the field, EurAI is uniquely positioned to oversee this project and ensure its accuracy, impartiality, and ongoing relevance. By embracing this initiative, EurAI can:

- Provide an authoritative resource on Europe's Artificial Intelligence history.
- Foster a stronger sense of European Artificial Intelligence identity and community.
- Support educational initiatives and policy discussions.
- Highlight Europe's ongoing role in shaping the global Artificial Intelligence landscape.
- Through careful curation of this historical timeline, we can better appreciate Europe's Artificial Intelligence legacy, inform its present, and inspire its future in this transformative and decisive research field.

4.2 Future steps

After the workshop on the History of AI in Europe, we propose the next steps:

1. To agree on a list of inclusion criteria;
2. Submit this list to the EurAI board and
3. To publish the timeline on the EurAI Web page.

5 Acknowledgements

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