Sr. Rector Magnífico y Sr. Vicerrector, dear Fede, thank you for your generous words that have moved me. Illustrious academic authorities, distinguished professors, authorities, colleagues, friends and family ... I thank you all for your presence in this solemn and moving act to grant me an honorary degree. Thank you for the effort you have made to be here, sharing this memorable moment with me.

It is a great honor for me to receive this distinction that I accept with great enthusiasm, responsibility and humility. Distinction that I would like to share with all the people and institutions that have always supported me and have believed in me. Without them I would not be here today: starting with my parents -whose unconditional support, infinite love and profound wisdom have given me the wings to fly while at the same time always offered me a solid branch and a warm nest where to return, my siblings and relatives, my friends, my teachers, colleagues, managers and mentors, researchers (past and present) with whom I have collaborated during my scientific career and, of course, my three wonderful children and my husband, Kristof, "my partner in crime", tireless companion, best friend, wise mentor and loving partner in this intense and exciting adventure that is life, with many surprises -like this is a doctorate-... as Mark Twain said, *"to get the full value of joy, you have to have someone to divide it with"*. In my case, without a doubt, my joys are full.

Hence, this recognition is for all of you, because without your help, your support and your collaboration I would not have been capable of achieving what we have achieved together.

As a native of Alicante, I am especially excited to receive this honorary doctorate at a university in my region whose beginnings, curiously, coincide with the beginnings of my scientific career. The UMH was created in December of 1996, just over a year after I started my PhD at MIT. In these two decades, the UMH has managed to stand out as the fifth and sixth university nationwide for its results of innovation and technological development in areas as important as neuroscience, biotechnology, health sciences, statistics or engineering. Since my return to Alicante 3 years ago, I have had the opportunity to visit and collaborate with the UMH on several occasions, which, by the way, I hope will not be the only ones. In all of them, I have been impressed by the diversity of initiatives that take place here -beyond the purely academic ones-, the modern and innovative character of this university and its teaching staff, and its open-mindedness, as reflected in the selection of a person with my profile for this honorary degree: a woman (I'm the seventh of 52 honorary doctorates), the first female engineer and relatively young (well, at least I'm not in retirement age yet).

Eleanor Roosevelt said that the *future belongs to those who believe in the beauty of their dreams*. And not only for Anaïs Nin but also for me, dreams are necessary for life. In fact, in my life, I have had and continue to have many dreams, dreams that have inspired me, have encouraged me and have helped me find my way. Therefore, today I would like to share with you some of my dreams, both those that over time have become, to my surprise, a reality, and others that I would love to see come true in the future.

Shortly before the UMH was born, when I was an EECS student at the UPM, I discovered Artificial Intelligence, the area in Computer Science to which I have dedicated my professional life. And it was love at first sight.

In fact, my first scientific publication ever was about neural networks. I had the opportunity to present my ideas on the topic at a conference in Rome, under the mentorship of the excellent professor –and later friend—Carmen Sanchez. The first project that I implemented in this field was part of my final project whose objective was the automatic detection of car license plates from highway surveillance videos. It was the first time that I wrote a computer program to do something “intelligent”. I clearly remember the feeling of empowerment and surprise when I managed with my program not only to detect the cars automatically but also to track them. It was through this project that I understood the power of information technology in general and specifically of Artificial Intelligence to help us address complex problems, to perform tasks in more efficient and scalable ways and to create technology that understands and helps us. It was at that moment that my first *big dream* became clear: going to the USA to study a PhD in Artificial Intelligence.

Thus, upon finishing EECS in Madrid I applied for a prestigious fellowship from “La Caixa Foundation” to carry out postgraduate studies in the USA. I was lucky, and I got it. For this reason, La Caixa Foundation holds a very special place in my heart. But my fortune did not end there. I was even luckier, and they accepted me in the 7 American universities where I had applied, including Stanford, Caltech, Carnegie Mellon and MIT. After a difficult decision process since I could only choose one university (how could I say no to Stanford, or Caltech?), I finally decided to study at MIT, and more specifically in his legendary Media Lab, under the direction of Prof Sandy Pentland, with whom I began my scientific career, from whom I learned - and I continue to learn - so much and to whom I am forever grateful.

At MIT I spent years of intense but also fun and enriching work; of unforgettable experiences - the demos (“demo or die” is the Media Lab’s motto), the events with the sponsors, the first smart clothes fashion show in the world, learning how to race formula Dodge cars… - years of constant learning, of great creativity and intellectual stimulation; of experiencing an extremely positive culture, where risk-taking is encouraged, where mistakes are gifts of life to learn and where there is no limit other than your own imagination. A culture that has marked me since then and that is part of my identity. During these years I forged intense friendships with extraordinary people whose contributions to science and society have been and are being profound. It was also a hard period, living thousands of kilometers from my family, working non-stop, in an inhospitable climate both in the winter -I do not miss the snow storms and freezing temperatures in Boston- and in the summer -with suffocating heat and humidity.

After finishing my PhD and my projects at MIT, I embarked on another personal and professional adventure, joining Microsoft Research in Redmond, WA as a researcher -the only female Spanish researcher, by the way. I worked with Eric Horvitz, current director of Microsoft Research. At Microsoft I had my first research experience outside the university and the privilege of doing it in one of the best -if not the best-research laboratories in my field in the world. Both Eric Horvitz and Mary Czerwinski, my two great mentors along with Jennifer Chayes, not only introduced me to the fascinating world of research in an industrial context, but also became great friends. Thank you, Eric, Mary, Jennifer, for your support and help during these almost two decades.

It was during this period at Microsoft that I realized that if my dream -another one- was to get computers -in the broadest sense- to understand humans -as a necessary step before they could help us, I should focus on mobile phones. I realized already back then that the most personal computer was the mobile phone (and I thought that it would continue to be in the future). For this reason, since 2005 I have carried out research projects almost exclusively related to mobiles.

In the 12+ years that I lived in the USA, I always wished I could return to Spain, but I never thought that one day I could do it. Hence, for a long time, a possible return was just another of my *dreams*.

But eleven years ago, Fortune -well, it was actually Telefónica- knocked on my door with an opportunity to see that dream come true: my return to Spain as Scientific Director - the first female - for Telefónica R&D in Barcelona. I will always be grateful to Dr. Carlos Domingo for betting on me. The challenge was big: defining the vision of a new research area (Artificial Intelligence, Big Data ...), identifying and attracting talent, publishing, patenting, creating an internship and visiting researcher programs... At the same time, it was a wonderful opportunity to return to Spain and contribute to the scientific progress in my country. And so, eleven years ago, my family and I embarked on a new adventure in Barcelona, an adventure that would not have been such without the enthusiastic support of Kristof, my husband, the main architect behind our return.

I feel very proud of the work done during the almost 9 years in Telefónica R&D: a dozen awards and nominations for best scientific article; dozens of patents; research projects transferred to products, which led to the creation of new products -or even companies; contribution to the creation of the Big Data and Artificial Intelligence area globally; creation of the area of Big Data for the Social Good ...

They say that life is cyclical (the circle of life) and it has certainly been in my case, offering me the opportunity to fulfill a *fourth dream* that I never imagined that I would see fulfilled one day: returning to my hometown, Alicante. However, 3 years ago, for personal reasons, we decided to move here to be with my family. Thanks to technology we have been able to turn into reality what for dozens of years seemed impossible. Both my husband -who is still working as a SW architect for Microsoft in Seattle- and I work from home. Thanks to technology we have been able to find a balance between an intense and global professional life, and a no less intense, but more local, personal life. While in Alicante, I decided to leave Telefonica to embark on three new adventures: Data-Pop Alliance - an NGO dedicated to Big Data and the AI ​​for Social Good, created by the MIT Media Lab, the Harvard Humanitarian Initiative, the Overseas Development Institute and Flowminder-- where I'm Chief Data Scientist; Vodafone, where I am the first Director of Research in Data Science; and the Vodafone Institute -a Berlin-based ThinkTank focused on studying the impact of technology on society- where I am Chief Scientific Advisor. This professional change would not have been possible without the support and insistence of Dr. Katia Walsh, who is with us today. Thank you, Katia, for your constant enthusiasm, for your innovative spirit and for the trust you have always placed in me. It is a privilege to work with you.

In addition, given that I live in Alicante now, I try to have some impact in this region, giving lectures at universities, talks to broad audiences and particularly to teenagers to inspire new generations to study technological careers; organizing or helping to organize science and technology events (the next one will be a conference on AI on November 23 at the ADDA in Alicante, to which you are all invited), collaborating with the media and advising the European Commission and the Valencian and National Governments on technology and especially on AI and Big Data. By the way, the White Paper on AI commissioned by the government should be published in the coming months.

This land, my land, has welcomed us warmly. And although there are many people who have helped us and I could not mention them all now, I would like to especially thank Andrés Pedreño, Manuel Bonilla, Manuel Desantes, Alvaro Bertran, Jose Iborra, Christoff and Mar, Philippe and Nuria, the Rotary clubs from Alicante and Alicante Puerto, Leandro Tortosa, Carolina Pascual, Toni Cabot, Juan Ramon Gil, Manuel Llorca, Oscar Bonastre, Jesus Pastor, Federico Botella, Esperanza Navarro, for your unconditional support, for opening your homes and hearts, and for including us in numerous local and / or regional initiatives that illustrate how alive, creative and dynamic is this region.

For approximately 25 years, I have focused my research activity on the computational modeling of human behavior using artificial intelligence techniques. I have worked with smart rooms, clothes, cars and phones. I have invented systems that are able to recognize human behaviors or traits, such as: facial expressions [1], activities [2], human interactions [3], driving maneuvers [4], sleep apnea [5], credit scoring [6], boredom [7]…I have built interactive, intelligent systems in computers and mobile phones, such as [8] [9]. Thanks to having developed my scientific career in a business context, I have been able to feel, first hand, the happiness that floods you when you experience how what was no more than an idea - sometimes even a bit crazy - becomes a reality that may help millions of people.

I have been not only a witness but also an active participant in technological progress, in the increasingly relevant and ubiquitous presence of technology in our lives and in the co-dependency that we have developed with it.

During my career, the inspiration and driving force of my work has always been a question with a clear social application. In all my projects, the person - individually or collectively - has been and is the central element: technology by and for society. Technology that understands us, as a previous step to be able to help us. However, today, more than ever, I am concerned about the impact this technology is having on our lives, an impact that is not necessarily always positive.

The availability of huge amounts of human behavioral data, partially because of the ubiquity of mobile devices (there are already many more mobile phones in the world than humans) are transforming the world that we live in. Today we have massive amounts of data that can be used to train artificial intelligence algorithms that allow researchers, companies, governments and other public sector actors to address complex problems. Decisions with both individual and collective impact that were previously taken by humans - often experts - are nowadays taken by AI systems, i.e. by algorithms, including decisions regarding judicial sentences, job offers, credit and loan granting, medical treatments and diagnoses, or the purchase-sale of shares on the stock market. Data-driven algorithmic decisions have the potential to improve our decision making. In fact, history has shown that human decisions are far from perfect: they are subject to conflicts of interest, corruption and cognitive biases, which has resulted in unfair and / or inefficient processes and outcomes. Therefore, the interest towards the use of algorithms can be interpreted as the result of a demand for greater objectivity in decision making.

However, data-driven algorithmic decisions are not exempt of limitations [10]. Interestingly, Plato’s words 2400 years ago are surprisingly valid, *“a good decision is based on knowledge, not on numbers (data)”.*

I would like to highlight 5 limitations –which are captured by the acronym FATED[[1]](#footnote-1)-- that I believe we would need to address to ensure that this new way of making decisions has a positive impact on society:

1. **F of fairness:** Data-driven algorithmic decisions may discriminate because the data used to train said algorithms is biased giving rise to discriminatory decisions; because of the use of a certain algorithm; or because of the misuse of certain models in specific contexts. In addition, data-driven algorithmic decision processes may imply that people are denied opportunities not because of their own actions, but because of the actions of others with whom they share certain characteristics. For example, some credit card companies have reduced the credit limit of their customers not because of their customer's payment history, but because of analyzing the behavior of other customers with a poor payment history who happened to have purchased in the same establishments as the other customers. Different solutions have been proposed in the literature to face algorithmic discrimination and maximize justice. However, I would like to underline the urgency for experts from different fields (including law, economics, ethics, computer science, philosophy and political science) to invent, evaluate and validate in the real-world different metrics of algorithmic justice for different tasks. In addition to this empirical research, it is necessary to propose a framework of theoretical modeling - supported by empirical evidence - that helps the users of these algorithms to make sure that the decisions are as fair as possible.

2. **A of accountability:** As more and more decisions affecting millions of people are automatically made by algorithms, we need to be clear about who is responsible for the consequences of such decisions, as it is the case with the rest of products and services that we use in society. Transparency is often considered to be a fundamental factor for clarity in the attribution of responsibility. However, transparency and audits are not enough to guarantee clear accountability.

3. **T of transparency:** Transparency refers to the quality of being able to understand a computational model. Hence, a model is transparent if a person can observe it and understand it easily. Therefore, transparency can be a mechanism that contributes to the accountability of the model. Burrell [11] proposes three types of opacity –*i.e.* lack of transparency—in data-driven algorithmic decisions: (1) intentional opacity, whose objective is the protection of the intellectual property of the inventors of the algorithms. This type of opacity could be mitigated with legislation that would force decision-makers towards the use of open source systems. The new European General Data Protection Regulation (GDPR)[[2]](#footnote-2) with a “right to an explanation” is an example of such legislation. However, powerful commercial and governmental interests might make it difficult to eliminate intentional opacity; (2) illiterate opacity, due to the fact that the vast majority of people lack the technical skills to understand the underpinnings of algorithms and machine learning models built from data. This kind of opacity might be attenuated with stronger education programs in computational thinking and “algorithmic literacy" and by enabling independent experts to advise those affected by algorithmic decision-making; and (3) intrinsic opacity, which arises by the nature of certain machine learning methods that are difficult to interpret (e.g. deep learning models). This opacity is well known in the machine learning community (usually referred to as the interpretability problem).

Moreover, it is of paramount importance that data-driven algorithmic decision making systems are transparent regarding not only which human behavioral data they capture and analyze, but also for which purposes (which is also included in the European GDPR) and in which situations humans are interacting with artificial systems (*e.g.* chatbots) vs with other humans.

4. **E of ethics:** Data-driven algorithmic decision-making processes generate important ethical dilemmas regarding what should be the appropriate actions to take based on the inferences carried out by such algorithms. Therefore, it is essential that decisions are made in accordance with a clearly defined and accepted ethical framework. There are several examples of ethical principles proposed in the literature for this purpose and of institutes and research centers created for this purpose, such as the Digital Ethics Lab at the University of Oxford or the AI ​​Now Institute in NYU. The European Commission recently created a high-level expert group on ethics and Artificial Intelligence with which I collaborate. However, this is still an active research area and there is no single method to embed ethical principles into data-driven algorithmic decision-making processes. I would highlight the importance that all developers and professionals working in the development and use of decision-making algorithms behave in accordance with a clear Code of Conduct and Ethics defined by their organizations. As Disney wisely said*“It is not hard to make decisions when you know what your values are”*

**and E of Education:** It is vitally important that we devote resources to digital literacy and Computational Thinking programs for all citizens, from children to the elderly. Otherwise, it will be very difficult, if not impossible, for us as a society to make decisions about technologies that we do not understand and that, consequently, we often fear. I fully agree with the words of Marie Curie, "*nothing in life is to be feared, it is only to be understood. Now is the time to understand more, so that we may fear less".*

In the book "Digital natives do not exist" I wrote a chapter called "digital erudites" that emphasizes the need to teach both Computational Thinking from the first grade, as well as to develop critical thinking, creativity and social and emotional intelligence skills which we are not developing today. I believe that these areas will be increasingly important for our mental health and our peaceful and harmonious coexistence both with technology, with other humans and with our planet.

5. **D of diversity:** Given the variety of use cases where we can apply Artificial Intelligence, we should reflect on the frequent lack of diversity in the teams that create today’s AI systems. In the future, we should make sure that teams are diverse both in terms of the areas of knowledge and regarding demographic factors -and especially gender, where the percentage of professional women in IT is less than 20% in many technology companies. Likewise, personalization and recommendation algorithms often suffer from lack of diversity in the results, tending to frame their users in certain patterns of tastes, which gives rise to the appearance of what Pariser has called the *filter bubble* [12]. This lack of diversity in personalization / recommendation is not desirable, as it limits the opportunities of technology to help us discover content (e.g. movies, books, music, news or friends) different to our own tastes and therefore content that would help us understand other points of view.

In addition to incorporating these 5 dimensions we should develop systems where the:

(1) Ownership and management of data are focused on people, avoiding any mismanagement or inappropriate use and always preserving privacy. An element that is often ignored is that advances in algorithms combined with the availability of new human behavioral data (e.g. social media data) allow the inference of private information (e.g. sexual orientation, political inclinations, education level, emotional stability) that has never been explicitly revealed by people. This element is essential to understand the implications of the use of algorithms as has been evident in the recent Facebook / Cambridge Analytica scandal.

and encourage the creation of

(2) laboratories (living labs) to experiment and co-create policies and solutions based on Artificial Intelligence, but consensual with humans and human values.

It will only be when we respect these requirements that we will be able to move forward and achieve another one of *my dreams*: a model of democratic governance based on data and artificial intelligence, by and for the people.

I do not know what the future will bring and where we will be in 20 years. But I can dream how I would like it to be. Therefore, I conclude my speech by sharing three dreams for the future with you.

First, I would like it to be a future where technology in general -and Artificial Intelligence in particular- is an integral part of our lives, where we co-exist synergistically and harmoniously with technology that helps us not only to live longer, but also to live better, all of us. The potential to have a positive impact is immense and I believe that we should not miss this opportunity. However, it is not a certain future as I have previously articulated. Therefore, we must seriously address the challenges and limitations presented by current Artificial Intelligence systems -including those previously described- to make this dream a reality. I hope not only to be part of that future but also and very especially to be able to contribute to it with my work.

Secondly, I dream that Spain will invest much more in Artificial Intelligence than it currently does, complying with the principles explained above, to become a leader in Europe, a bridge with Latin America and Africa, standing out for an ambitious commitment, with scientific excellence, investment in the nurturing, attraction and retention of talent, promotion of creativity and innovation, high business growth and, consequently, a high quality of life for all.

Finally, I hope, I wish - and I dream – that there will be more female researchers, inventors and innovators in technology, who are exceptional and recognized not because of being women, but because of the brilliance of their ideas and the impact of their job.

Thank you for contributing with this recognition to turn one of my dreams into a reality.

**Bibliography**

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| [1]  | N. Oliver, A. Pentland and F. Berard, "LAFTER: lips and face real time tracker," in *Proceedings of IEEE Computer Society Conference on Computer Vision and Pattern Recognition*, San Juan, Puerto Rico, USA , 1997.  |
| [2]  | N. Oliver, E. Horvitz and A. Garg, "Layered representations for human activity recognition," in *Proceedings. Fourth IEEE International Conference on Multimodal Interfaces*, Pittsburgh, PA, USA , 2002.  |
| [3]  | N. Oliver, B. Rosario and S. Pentland, "A Bayesian computer vision system for modeling human interactions," *IEEE Trans. Pattern Anal. Mach. Intell.,* vol. 22, no. 8, pp. 831-843, 2000.  |
| [4]  | N. Oliver and A. Pentland, "Graphical models for driver behavior recognition in a SmartCar," in *Proceedings of the IEEE Intelligent Vehicles Symposium 2000*, Dearborn, MI, USA , 2000.  |
| [5]  | N. Oliver and F. Flores-Mangas, "HealthGear: a real-time wearable system for monitoring and analyzing physiological signals," in *International Workshop on Wearable and Implantable Body Sensor Networks*, Cambridge, MA, USA , 2006.  |
| [6]  | J. San Pedro, D. Proserpio and N. Oliver, "MobiScore: towards universal credit scoring from mobile phone data," in *International Conference on User Modeling, Adaptation, and Personalization*, 2015.  |
| [7]  | M. Pielot, T. Dingler, J. San Pedro and N. Oliver, "When attention is not scarce-detecting boredom from mobile phone usage," in *Proceedings of the 2015 ACM International Joint Conference on Pervasive and Ubiquitous Computing*, Osaka, Japan, 2015.  |
| [8]  | N. Oliver and F. Flores-Mangas, "MPTrain: a mobile, music and physiology-based personal trainer," in *Proceedings of the 8th conference on Human-computer interaction with mobile devices and services*, Helsinki, Finland, 2006.  |
| [9]  | R. de Oliveira, M. Cherubini and N. Oliver, "MoviPill: improving medication compliance for elders using a mobile persuasive social game," in *Proceedings of the 12th ACM international conference on Ubiquitous computing*, Copenhagen, Denmark, 2010.  |
| [10]  | B. Lepri, N. Oliver, E. Letouzé, A. Pentland and P. Vinck, "Fair, Transparent, and Accountable Algorithmic Decision-making Processes," *Philosophy & Technology,* pp. 1-17, 2017.  |
| [11]  | J. Burrell, " How the machine ‘thinks’: Understanding opacity in machine learning algorithms," *Big Data and Society ,* 2016 .  |
| [12]  | E. Pariser, The filter bubble: how the personalized web is changing what we read and how we think, New York: Penguin Books, 2012.  |
| [13]  | N. . Oliver, A. . Pentland and F. . Bérard, "LAFTER: a real-time face and lips tracker with facial expression recognition," *Pattern Recognition,* vol. 33, no. 8, pp. 1369-1382, 2000.  |
| [14]  | M. Brand, N. Oliver and S. Pentland, "Coupled hidden Markov models for complex action recognition," in *Proceedings of IEEE Computer Society Conference on Computer Vision and Pattern Recognition*, San Juan, Puerto Rico, USA , 1997.  |
| [15]  | A. Karatzoglou, X. Amatriain, L. Baltrunas and N. Oliver, "Multiverse recommendation: n-dimensional tensor factorization for context-aware collaborative filtering," in *Proceedings of the fourth ACM conference on Recommender systems*, Barcelona, Spain , 2010.  |
| [16]  | J. Froelich, J. Neumann and N. Oliver, "Sensing and Predicting the Pulse of the City through Shared Bicycling," in *Proceedings of Twenty-First International Joint Conference on Artificial Intelligence*, 2009.  |
| [17]  | S. Lluna and J. Pedreira, Los nativos digitales no existen, Deusto Editorial , 2017.  |
| [18]  | S. Centellegher, M. De Nadai, M. Caraviello, C. Leonardi, M. Vescovi, Y. Ramadian, N. Oliver, F. Pianesi, A. Pentland, F. Antonelli and B. Lepri, The Mobile Territorial Lab: a multilayered and dynamic view on parents’ daily lives, EPJ Data Science, 2016.  |
| [19]  | J. Staiano, N. Oliver, B. Lepri, R. de Oliveira, M. Caraviello and N. Sebe, "Money walks: a human-centric study on the economics of personal mobile data," in *Proceedings of the 2014 ACM International Joint Conference on Pervasive and Ubiquitous Computing*, Seattle, WA, USA , 2014.  |
| [20]  | Y. Torres Fernández, D. Pastor Escuredo, A. Morales Guzmán, J. Baue, A. Wadhw, C. Castro Correa, L. Romanoff, J. Lee, A. Rutherford, V. Frias Martínez, N. Oliver, E. Frias-Martinez and M. Luengo-Oroz, "Flooding through the lens of mobile phone activity," in *Proceedings of IEEE Global Humanitarian Technology Conference*, San Jose, CA, USA , 2014.  |
| [21]  | S. Park, A. Matic, K. Garg and N. Oliver, "When Simpler Data Does Not Imply Less Information: A Study of User Profiling Scenarios With Constrained View of Mobile HTTP (S) Traffic," *ACM Transactions on the Web (TWEB),* vol. 12, no. 9, 2018.  |
| [22]  | J. Kroll, "Accountable Algorithms," PhD Dissertation in the Computer Science Department of Princeton, Princeton, US, 2015. |
| [23]  | S. Ahmad and J. Hawkins, "Properties of Sparse Distributed Representations and their Application to Hierarchical Temporary Memory," Arxiv, 2015. |
| [24]  | N. Bostrom, SuperIntelligence: Paths, dangers, strategies, Oxford, UK : Oxford University Press, 2014.  |
| [25]  | D. Rumelhart, G. E. E. Hinton and R. J. Williams, "Learning representations by back-propagating errors.," *Nature ,* vol. 323, pp. 533--536, 1986.  |
| [26]  | J. Hawkins, "What intelligent machines need to learn from the neocortex," *IEEE Spectrum ,* 2017.  |
| [27]  | M. Arntz, T. Gregory and U. Zierahn, "The Risk of Automation for Jobs in OECD Countries: A Comparative Analysis," *OECD Social, Employment and Migration Working Papers,* vol. 189, no. OECD Publishing , 2016.  |
| [28]  | S. Bocconi, S. Chioccariello, G. Dettori, A. Ferrari and K. Engelhardt, "Developing computational thinking in compulsory education," JCR Science for Policy Report, 2016. |
| [29]  | Y. Shi, A. Karatzoglou, L. Baltrunas, M. Larson, N. Oliver and A. Hanjalic, "CLiMF: learning to maximize reciprocal rank with collaborative less-is-more filtering," in *ACM conference on Recommender systems*, New York , 2012.  |
| [30]  | X. Amatriain, N. Lathia, J. Pujol, H. Kwak and N. Oliver, "The wisdom of the few: a collaborative filtering approach based on expert opinions from the web.," in *32nd international ACM SIGIR conference on Research and Development in Information Retrieval* , 2009.  |
| [31]  | A. Bogomolov, B. Lepri, J. Staiano, N. Oliver, F. Pianesi and A. Pentland, "One upon a crime: towards crime prediction from demographics and mobile data," in *16th International Conference on Multimodal Interaction* , 2014 .  |
| [32]  | M. Vieira, V. Frias-Martinez, N. Oliver and E. Frias-Martinez, "Characterizing Dense Urban Areas from Mobile Phone-Call Data: Discovery and Social Dynamics," in *IEEE Second International Conference on Social Computing*, Minneapolis, MN, USA, 2010.  |
| [33]  | R. Steinpreis, K. Anders and D. Ritzke, "The Impact of Gender on the Review of the Curricula Vitae of Job Applicants and Tenure Candidates: A National Empirical Study," *Sex Roles,* vol. 41, no. 7--8, pp. 509-528, 1999.  |
| [34]  | P. Jawandhiya, "Hardware design for machine learning," *International Journal of Artificial Intelligence and Applications (IJAIA),* vol. 9, no. 1, pp. 63 -- 84, 2018.  |

1. http://www.esadeknowledge.com/view/7-challenges-and-opportunities-in-data-based-decision-making-193560 [↑](#footnote-ref-1)
2. https://www.eugdpr.org/ [↑](#footnote-ref-2)