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Intelligent data processing

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Invited seminar

The internet has itself evolved to optimize the connection between humans, creating faster, more creative and effective communication channels in the form of online newspapers, forums, chats, social networks, blogs and microblogs. It currently enables access to vast amounts of information on virtually any topic, greatly contributing to the spread of valuable knowledge among different countries and organizations. Today, a growing number of citizens are much more informed, not only about their local communities but also about what is happening around the world. They form opinions and world views and become active members of society, often voicing their concerns on social networks on topics such as pollution, global warming, the pandemic, war, politics, ethics and other social issues. None of this would have been possible if humans from across the world had not been able to communicate, share information and collaborate over the internet. Thus, the internet has played a central role in shifting our perspectives and shaping our identity.

In recent years, disruptive technologies have emerged and have revolutionized our communication capabilities over the internet. One of those technologies is Deep Learning. It fits under the broader branch of Artificial Intelligence known as Machine Learning.

Here are some examples of how Deep Learning has transformed communications:

- Computational linguistics, where it provides capabilities for natural language processing, speech recognition and machine translation. The applications of computational linguistics include automated translation, automated grammar and spelling check, automated readers for the blind and computer interfaces that recognize and respond to human speech.

- Computer vision, where it provides capabilities for image processing and analysis, pattern and object recognition and signal processing. The applications of computer vision include facial recognition, advanced image editing, generation of highly realistic images and videos which can be used in filmmaking, creating realistic online interaction between users, even if they speak in different languages.

Although non-governmental humanitarian and environmental organizations have been able to grow, collaborate, and take action, and ordinary citizens have had their voices heard across the globe thanks to social media, the internet in itself is just a tool and can therefore be used to cause as much harm as good.

The world of online information sharing has unfortunately also become a means for achieving ill-intentioned goals. Fake news, disinformation campaigns, and manipulated images and videos have plagued the internet which has had serious consequences on our society. The myriad of information available online mean that it may be difficult to distinguish between true and fake news, leading many users to unknowingly share fake news, contributing to the spread of misinformation. Some of the goals of spreading false information are described below:
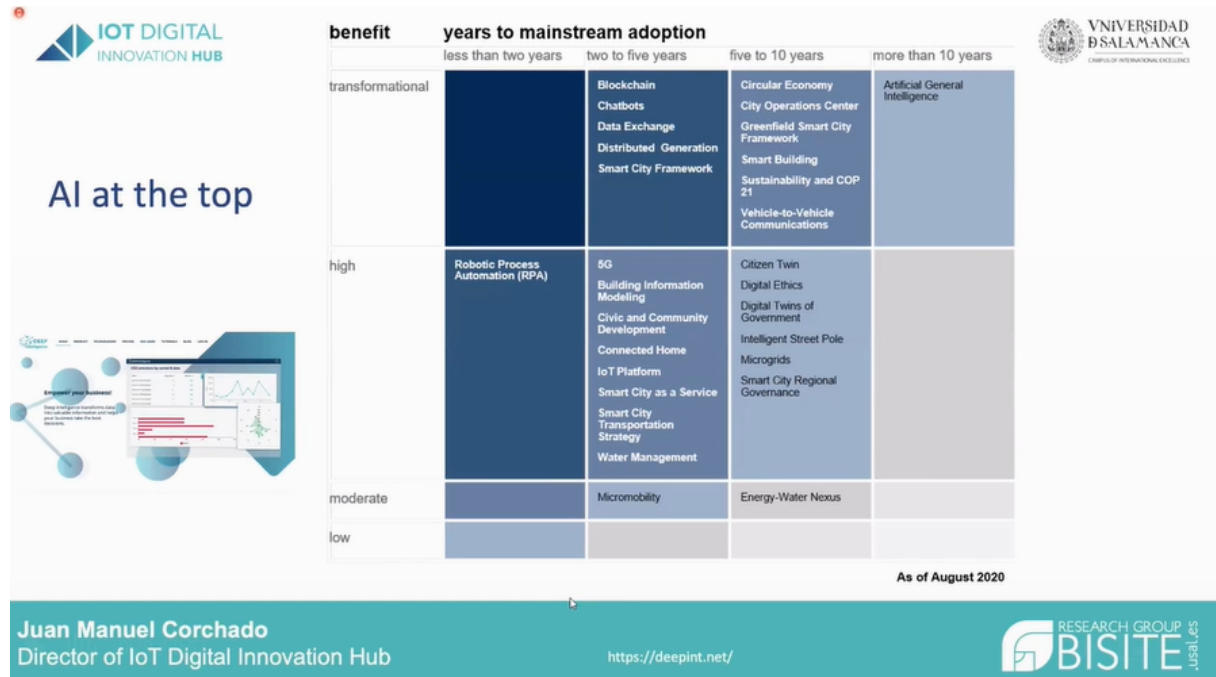
- **To distort peoples' beliefs and influence behaviour:** pseudo-scientific information and conspiracy theories can both have very serious consequences. Pseudo-scientific information often regards health and propagates quickly on social networks and news sites, convincing its readers to change their lifestyle or undertake an alternative treatment for an illness, claiming it to be a cure without any scientific evidence. The negative impact on fake health news has become very evident during the Coronavirus pandemic. False claims regarding Covid-19 prevention and cures have led many people to disobey the health measures taken by the authorities, such as wearing a mask, and many believed that getting vaccinated would be harmful for them or that it simply was not necessary. The power of social media in propagating false information is reflected in the fact that antivaccination became a movement. Many people have lost their lives and others have had to undergo severe illness because the belief that Covid does not exist led them to not following the advice of health authorities. Conspiracy theories claim to have discovered a secret plot behind which stands a powerful organization. A powerful example of the damage caused by the spread of such theories can be seen in the example of the Pizzagate conspiracy theory. This theory emerged in 2016 during the US elections and it claimed that Democratic Party officials had connections with restaurants with an alleged human trafficking and sex ring[1]. The listed restaurants experienced many threats and both owners and employees were harassed, as the fake news spread through social media. This theory led to a shooting at one of the pizzerias, carried out by a man who believed the fake news.

- **Political propaganda:** Political parties have been known to use propaganda prior to the invention of the internet. However, new technologies have helped politicians create more convincing propaganda through manipulating images and videos in their favor or to the disadvantage of their opponents. Moreover, online communication channels make it easy for propaganda to spread and reach a wider audience. This has been shown to profoundly influence public opinion. Psychological studies have demonstrated that, even if an image has been proven to be false, the human mind can continue to associate it negatively at an unconscious level, which may in turn affect the political party they support. For example, in 2020, Republican Paul A. Gosar tweeted a deepfake image of Obama shaking the hand of Iranian President, Hasan Rouhani, to undermine his opponent's image. Presumably, the Republican did not know it was a deepfake image.

- **Cybercrime:** Deepfake images and videos can be used to blackmail people in power with the aim of manipulating them. It is also possible to deepfake someone's voice and therefore, take on their identity with the aim of obtaining money.

- **Damage reputation:** Fake news, images and videos can be used to portray someone in a negative light or even accuse them of a crime.

As technologies become more advanced so do our possibilities. The use of Deep Learning to create fake images and videos has become known as deepfake. This means that there are ever more effective and realistic forms of deception on the internet, making it more difficult for internet users to distinguish reality from fiction.

Deep Convolutional Generative Adversarial Network (DCGAN) is one of the main technologies that enables the generation of highly realistic images. It uses two networks; the Generative Adversarial Network, which creates fake images, and the Convolutional Neural Network as the discriminator which differentiates the fake image from the real ones. The process of generating an image consists in the generator continually modifying it until the discriminator is no longer able to tell if the image is fake or not. This demonstrates the importance of being ahead of such technologies, through the development of

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[1] https://www.washingtonpost.com/local/pizzagate-from-rumor-to-hashtag-to-gunfire-in-dc/2016/12/06/4c7def50-bbd4-11e6-94ac-3d324840106c_story.html

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robust tools that will serve to identify and prevent fauxtography. Thus, as ironic as it may seem, technology is an enabler of both, the problem and the solution.

https://english.corchado.net/2021/03/04/smart-cities-development-of-intelligent-management-systems/

Currently, there are solutions aimed at detecting false messages, manipulating images or videos, and disinformation campaigns on social networks and other media using various artificial intelligence techniques, such as natural language processing or deep learning. Given that fauxtography is a criminal act and the falsity of the images/videos may have to be evidenced in court, technologies designed for this purpose cannot merely point to what they consider to be faux. Instead, they must provide detailed human-understandable reasoning behind the decision they have made, so that it can be used as evidence in court. To this end, Explainable Artificial Intelligence or XAI is needed. XAI is crucial, as its white-box approach means that human experts can interpret the internal workings of the model and thus, ensure that responsible decisions are made. In other words, XAI makes it possible for humans to rely on technology in scenarios where opaque technologies could not be used.

However, most of these proposals do not take into account the ethical impact that these methods may have on citizens' rights, especially as to what is false and what is not. It is therefore necessary to explore new methodologies and technological solutions for the effective detection of the spread of false news, disinformation campaigns and information issues and to take ethical measures in advance to mitigate their negative effects on electoral manipulation as well as possible damage to public health or individual honor.

There are a number of studies aimed at analyzing the phenomenon of false news and disinformation campaigns on social networks and other media, both from a sociological and a technological point of view. However, research aimed at creating methodologies or frameworks with the current sociological and technological approach is not common. At the technological level, there are solutions based on PLN techniques for analyzing the semantic content of messages disseminated by users, as well as sentiment analysis for detecting possible hate campaigns or supporting terrorist targets.

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There are also approaches based on perceptual hashing algorithms for viewing images and videos and their relationship to the spread of movements related to disinformation campaigns or terrorist movements.

On the other hand, there are proposals to detect false profiles or influencers on social networks using network graph analysis and a degree of centrality that shows the importance and influence of users on each other, as well as advanced feature extraction, including time series features that show consistency of behavior patterns. Graph neural networks are currently one of the most fruitful lines of research in the field of behavioral analysis, false reports or fauxtography on social networks (i.e., images used for dubious or false purposes in relation to the messages in which they are used).

Although approaches based on deep neural networks work very well compared to symbolic techniques, the resulting models are not reasonably interpretable to humans. Failure to understand why a model performs a particular classification or prediction in turn makes it difficult to create models that take into account the ethical and legal aspects that countermeasures may have to mitigate false reports or disinformation campaigns on citizens, especially when legitimate freedom of expression is violated. In this regard, it is necessary to examine artificial intelligence algorithms, natural language processing, and eXplainable Graphical Neural Networks, such as those based on neuro-symbolic approaches that allow models to be interpreted and ethical design rules to be followed.

The main challenges to be addressed in this area are:

- Considering the ethics of extracting data from the internet. The data extractions systems must work according to an ethical framework which complies with the law. This will make it possible to use technologies that detect deepfakes and online fraud as evidence in court. Thus, algorithms must be developed for the ethical reception of data from websites, blogs, e-mails, banners and social networks, as well as ontologies for the characterization of social relations, influence and information flows.

- Research the potential of eXplorable Graphical Convolutional Neural Networks. They are a subset of Deep Learning Neural Networks which can make inferences and predictions from the data shown on graphs. They could provide optimal tools for the recognition of patterns in the propagation of messages across different social media platforms.

- Research in the field of eXplainable Deep Behavioral Sequence Clustering. This technology is capable of automatically clustering sequences of data. Frameworks could be developed to detect spurious profiles.

- Investigate the capabilities of eXplainable Principal Component Analysis and reverse engineering for the detection of synthetic content. eXplainable Principal Component Analysis can increase the interpretability of data while reducing their dimensionality. Moreover, reverse engineering is capable of examining deepfake images and using deductive reasoning to determine whether an image is real or fake.

- Explore the possible applications of Recurrent Neural Networks. This type of artificial neural network is capable of speech recognition and natural language processing, to learn patterns of disinformation and fake news on social networks. Thus, Recurrent Neural Networks predicting disinformation campaigns among the most vulnerable citizens.

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