Proposition de sujet de thèse

Detection of weak signals in video streams with active reinforcement learning

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DATA2B makes Data Products. The company of about 15 employees was funded in 2015 by two engineers and a mathematician experimented in Telecoms, Big Data and Data Science. The company owns offices in Rennes, Paris, Barcelona and Mexico and got together experts in distributed infrastructure, Big Data software architecture, Data Science, Network Science and Geomatics. The company researches and develops data products – *i.e.* End-users applications on-demand solving specific problems thanks to proprietary models of analytic intelligence – for clients and/or partners such as KEOLIS (Transports), GROUPAMA (Insurances), MYRIAD GROUP, BOUYGUES (Telecoms), DAUNAT (Agroindustry) and RENNES METROPOLE (Smart City).

Keyword: *video, machine learning, sparsity.*

Subject:

Video digitizes images and audio streams. It is a cost-effective media for remote vision and for capturing physical events occurring around us. In recent applications, such as video surveillance, data streams are processed for finding patterns in order to aid human vision with machine learning. In other domains, such as Astrophysics, observational tools record phenomena appearing beyond the visual and audio spectrum, producing data that we could compare to video streams. In both cases, some people need to spend time observing data streams so as to find special events, which might be physical risks in sensible places or neutrinos before a red giant star collapses in a supernova somewhere in the Universe [3]. As Big Data and uninterrupted data flows easily escape from human attention and understanding, computer vision can massively process these data flows without interruption.

For identified events, such as fire and flames, computer vision is reliable and efficient as it can distinguish between flames and fire-colored moving objects, thanks to the use of spatial and temporal wavelet transforms [4]. Computer vision systems also enable the early detection of identified events and features, for autonomous vehicles and robots [2]. With unidentified events, the best way to efficiently detect and identify them remains human observation and analysis. As a result, detecting and recognizing unidentified events in data streams requires man-machine collaboration, instead of man-machine competition.

Active learning strives towards the collaboration of human intelligence and artificial intelligence. With supervised models in machine learning and deep learning, items must be previously labelled by experts and/or people answering to labelling queries – *e.g.* captcha. Active learning from relative queries, instead of absolute ones, makes it possible to train machine-learning algorithms from weak predictors, such as side information or non-experts answers, then to get comparable or better performance than with the experts' answers to labelling queries [1]. With such a model, item recognition relies on human information processing-based inputs, more than on human knowledge-based inputs.

The IoT and smart cities are going to produce huge and heterogenous datasets, to be compared with astronomical observations and collected in data lakes. Therefore, the detection of unexpected and/or unidentified events in data streams should become a significant task, depending on active learning for the future of society, science, and economy. Finally, detecting weak signals in videos streams thanks to active learning or other approaches could represent an important stake, while there currently appears no or few works published on this topic, to our knowledge. It might allow us to catch unusual phenomenon in video surveillance before specific events occur, so as to prevent risks. It might also allow cosmologists to be notified of unobserved phenomena that could require attention, in order to identify and classify them for an *active reinforcement learning* process.

The thesis we propose concerns the research and experimentation of both sparse representations [5] and online models of active learning for the detection of weak signals in data streams. It is focused on application in video surveillance and astronomical data surveillance. It will be experimented thanks to Big Data systems and Lambda architecture, allowing to run offline and online analysis tasks in parallel processes. The candidate should be interested in computer vision, online analysis and research applications. Candidate preferring a permanent position in private research after the thesis are welcome (Lead Researcher for online analysis @DATA2B).

References

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