Prof. Yan Zhang 14.04.2025

Reviewer's opinion

on Ph.D. dissertation authored by

Małgorzata Wasilewska

entitled:

NEW MACHINE LEARNING METHODS FOR SPECTRUM SENSING IN WIRELESS COMMUNICATION SYSTEMS

1. Problem and its impact

This dissertation studied the application of machine learning (ML) methods to spectrum sensing (SS) and spectrum prediction (SP) in cognitive radio networks. Spectrum sensing has been a long-standing challenging scientific problem. The ML solution has practical meaning in real wireless systems, and the implantation of the solutions is able to significantly increase the performance of real systems.

2. Contribution

This thesis focuses on the state-of-the-art research topic AI for communications networks. In particular, the thesis studied several key challenges and proposed innovative solutions to address these challenges. In energy decision method, different machine learning classifiers have been presented to evaluate the performance, including NB, kNN, RF, and SVM. Then, deep learning methods have been presented to improve the performance of spectrum sensing and predict spectrum occupancy, including NN, RNN and CNN. Two real-world datasets have been used to evaluate the performance. Further, the state-of-the-art distributed machine learning method federated learning has been studied to preserve privacy and exploit the potential of mobile devices/terminals. The thesis has a comprehensive survey of the existing studies on applying both centralized and distributed machine learning methods in spectrum sensing in cognitive radio networks. The study has made solid technical contributions with very good presentation. It is very impressive to see that the candidate has published high-quality papers in top-ranked journals and conferences.

3. Correctness

- The thesis has studied many different machine learning methods to improve the performance of spectrum sensing, including NN, RNN, CNN, SVM. The thesis has surveyed the method reinforcement learning, however, the method is not studied in the technical part of the thesis. The candidate may comment on this why reinforcement learning or deep reinforcement learning is not studied.
- The thesis may add discussion part on the potential of applying large model (e.g., LLM) or hybrid large/small model for spectrum sensing.
- Page 46, please present the feature of the dataset. Is the dataset randomly generated? Or is the dataset generated based on a distribution function? Or is the dataset from measured data in a real system? The reviewer has the similar question for the dataset in page 61.
- Chapter 4, each device uses CNN model to perform spectrum sensing. CNN normally has high computation load while devices are resources-limited. Is it possible to use CNN in each device? Further, we only need to know the result of On/Off of the spectrum, is it necessary to use CNN, which wants high computation cost?

4. Knowledge of the candidate

The thesis is within the scope of wireless communications and networks. The candidate has very good knowledge of wireless communications in general and deep knowledge of cognitive radio, spectrum sensing. Further, the candidate has deep understanding of exploring AI for communication and thus studied the state-of-the-art topic on AI for spectrum.

5. Other remarks[1]

6. Conclusion

Taking into account what I have presented above and the requirements imposed by Article 13 of *the Act of 14 March 2003 of the Polish Parliament on the Academic Degrees and the Academic Title* (with amendments)[2], my evaluation of the dissertation according to the three basic criteria is the following:

A. Does the dissertation present an original solution to a scientific problem? (the selected option is marked with **X**)

[x]	[ ]	[ ]	[ ]	[ ]
Definitely YES	*Rather yes*	*Hard to say*	*Rather no*	*Definitely NO*

B. After reading the dissertation, would you agree that the candidate has general theoretical knowledge and understanding of the discipline of **Information and Communication Technology**, and particularly the area of **AI for communications**?

[x]	[ ]	[ ]	[ ]	[ ]
Definitely YES	*Rather yes*	*Hard to say*	*Rather no*	*Definitely NO*

C. Does the dissertation support the claim that the candidate is able to conduct scientific work?

[x]	[ ]	[ ]	[ ]	[ ]
Definitely YES	*Rather yes*	*Hard to say*	*Rather no*	*Definitely NO*

Moreover, taking into account ... I **recommend to distinguish** the dissertation for its quality[3].

Signature

[1] Optional
[2] http://www.nauka.gov.pl/g2/oryginal/2013_05/b26ba540a5785d48bee41aec63403b2c.pdf
[3] Obviously, this sentence is optional.