Supplementary material
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Early Prediction of the Highest Workload in Incremental Cardiopulmonary Tests Using a ANN-based classifier

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This appendix reports additional experiments to support the evaluation of the proposed approach for the early prediction of the W_{peak} value using a classifier based on artificial neural networks (ANN). The ANN-based classifier predicts the W_{peak} value for a new test, each time the workload is increased, based on the following information:
1. Characteristics of the individual doing the test. They are represented by the factual data for the individual.
2. The cardiopulmonary response of the individual to the test. It is given by the peak value at prediction time in the $CPE_{peaks}[t]$ sequence, which summarizes the dynamic data for the test.

The appendix analyses the impact of parameter setting on the prediction error for the ANN-based classifier. These experiments have not been included in the paper due to the lack of space. Table I reports some parameter settings that have been analyzed. For these configurations, Sections I and II report the prediction error for datasets $D_{50\times2}$ and $D_{25\times2}$, respectively.

Experimental results show that, in both datasets, each parameter setting either improves or decreases the prediction error for tests with different W_{peak} values. Setting 1 has been selected as reference configuration, because it globally provides good performance on most tests in the two datasets. Experiments reported in the submitted paper have been run with this configuration.

Additional experiments have been run to analyze the impact of the training cycles parameter on the prediction error. We have observed that, by increasing the number of training cycles, the prediction error slightly reduces but the network training time increases. To trade-off prediction error and training time, we selected training cycles equal to 500.

I. Experimental results for dataset $D_{50\times2}$

Figures 1-5 plot the prediction error for dataset $D_{50\times2}$ with the parameter settings in Table I, by considering separately tests reaching the same W_{peak}.

For dataset $D_{50\times2}$, we have observed that, with respect to Setting 1, the other configurations provide the following experimental results:
- For some configurations (e.g., Setting 4), the prediction error increases in the first steps for longer tests (e.g., tests with W_{peak} 450 W).
- For some configurations (e.g., Settings 2 and 4) and tests, curves plotting the prediction error have a (slightly) more irregular trend.
- For some configurations (e.g., Settings 3 and 4), the prediction error is lower for shorter tests (e.g., tests with W_{peak} 250 W).

II. Experimental results for dataset $D_{25\times2}$

Figures 6-10 plot the prediction error for dataset $D_{25\times2}$ with the parameter settings in Table I, by considering separately tests reaching the same W_{peak}.

For dataset $D_{25\times2}$, we have observed that, with respect to Setting 1, the other configurations provide the following experimental results:
- For some configurations (e.g., Settings 3 and 4), the prediction error increases in the first steps for longer tests (e.g., tests with W_{peak} 375 W).
- For some configurations (e.g., Setting 3) and tests, curves plotting the prediction error have a (slightly) more regular trend, but the prediction error is higher.
- For some configurations (e.g., Setting 2), the prediction error is lower for shorter tests (e.g., tests with W_{peak} 250 W).

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Parameter setting	Training cycles	Learning rate	Momentum	Hidden layer
Setting 1	*500*	*0.3*	*0.2*	*1*
Setting 2	500	0.3	0.2	2
Setting 3	500	0.2	0.3	1
Setting 4	500	0.2	0.3	2
Setting 5	500	0.4	0.2	2

TABLE I
PARAMETER SETTING FOR THE ANN-BASED CLASSIFIER

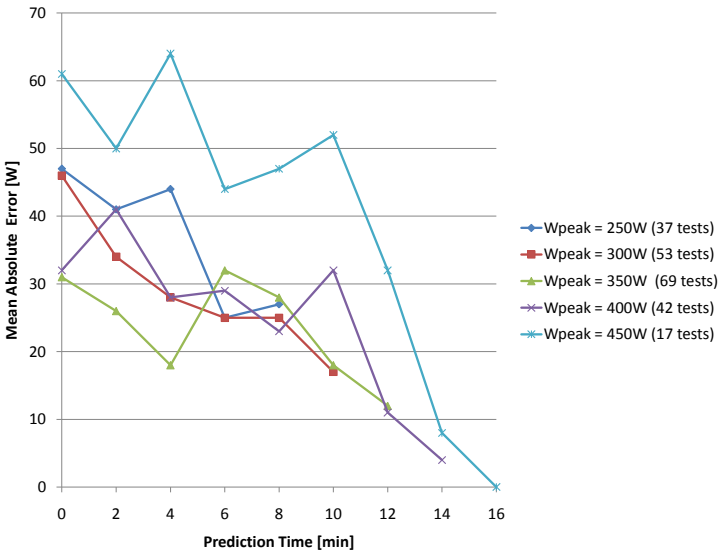


Fig. 1. Dataset $D_{50\times2}$: Setting 1 (*training cycles* = 500, *learning rate* = 0.3, *momentum* = 0.2 , *hidden layer* = 1)

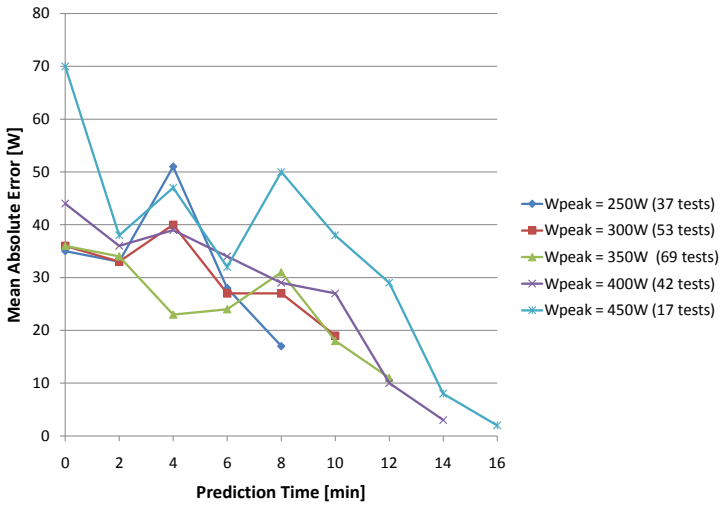


Fig. 2. Dataset $D_{50\times2}$: Setting 2 (*training cycles* = 500, *learning rate* = 0.3, *momentum* = 0.2 , *hidden layer* = 2)

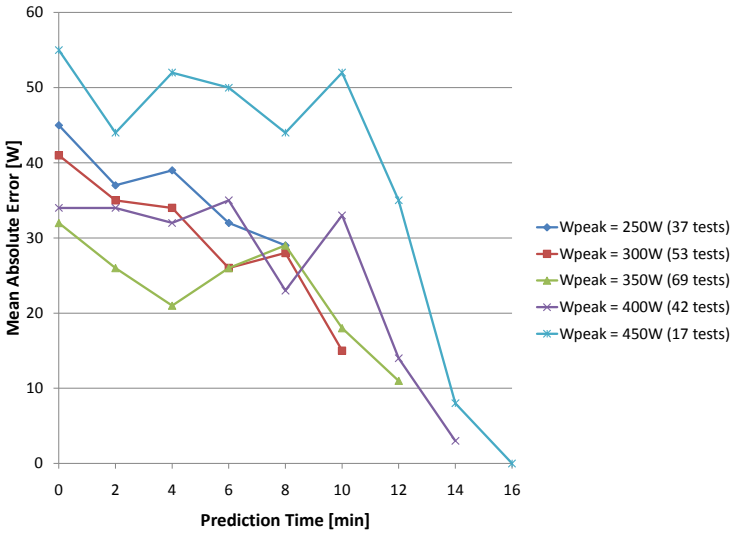


Fig. 3. Dataset $D_{50\times2}$: Setting 3 (*training cycles* = 500, *learning rate* = 0.2, *momentum* = 0.3 , *hidden layer* = 1)

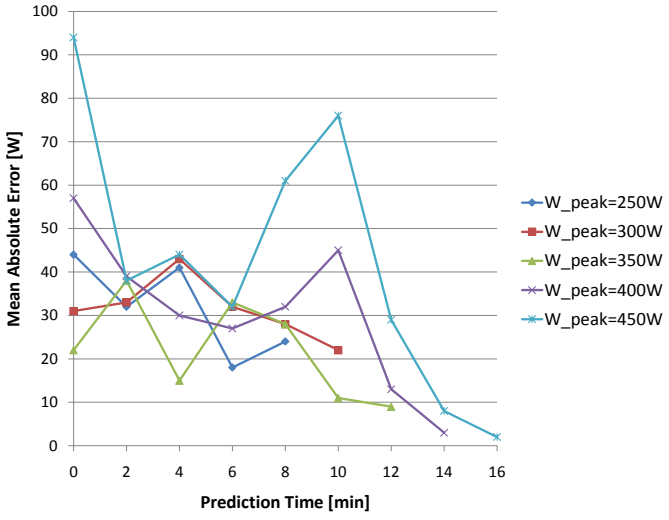


Fig. 4. Dataset $D_{50\times2}$: Setting 4 (*training cycles* = 500, *learning rate* = 0.2, *momentum* = 0.3 , *hidden layer* = 2)

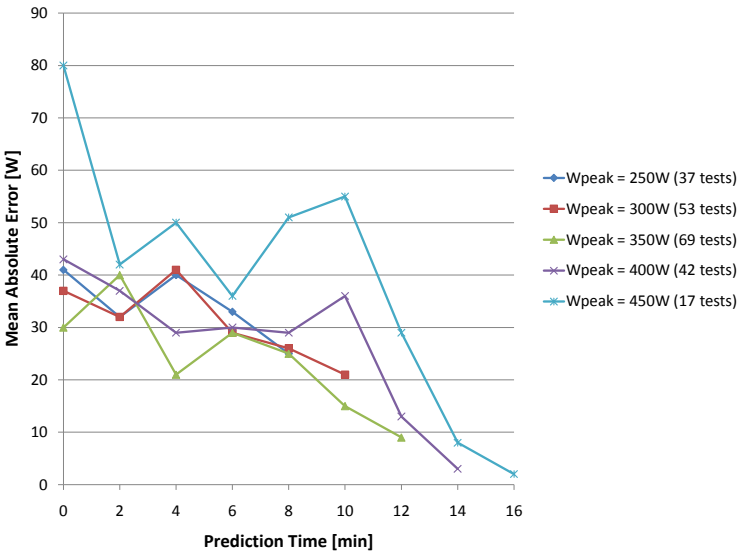
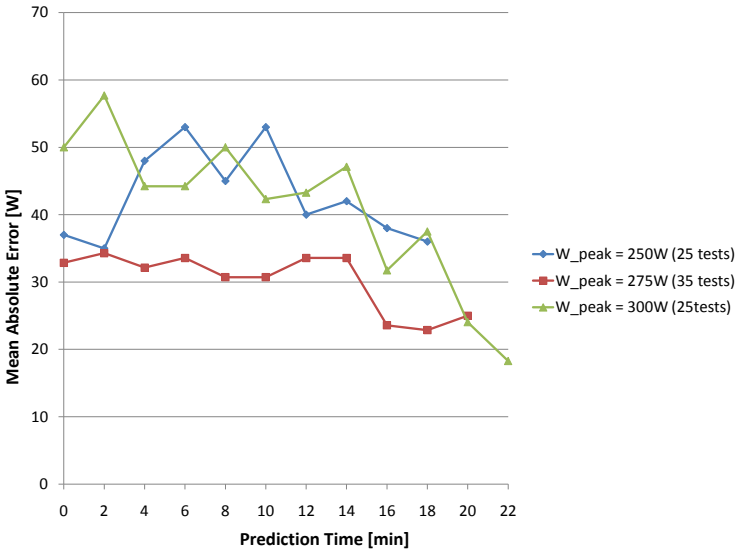
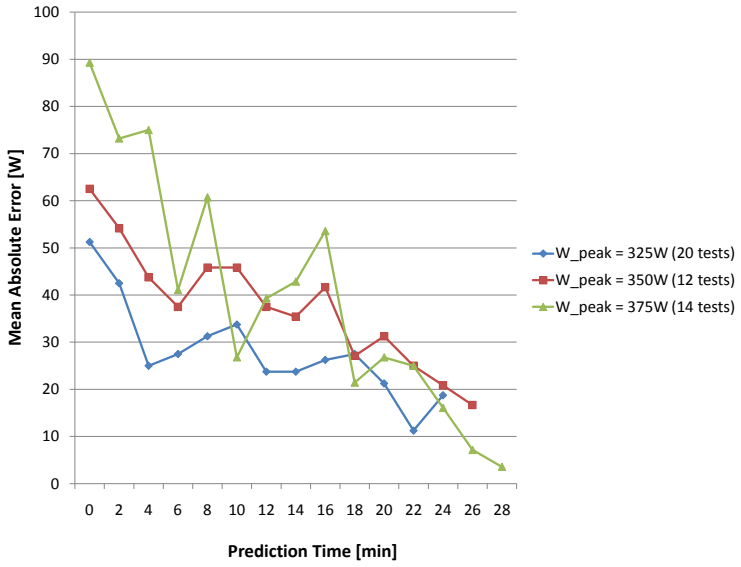


Fig. 5. Dataset $D_{50\times2}$: Setting 5 (*training cycles* = 500, *learning rate* = 0.4, *momentum* = 0.2 , *hidden layer* = 2)

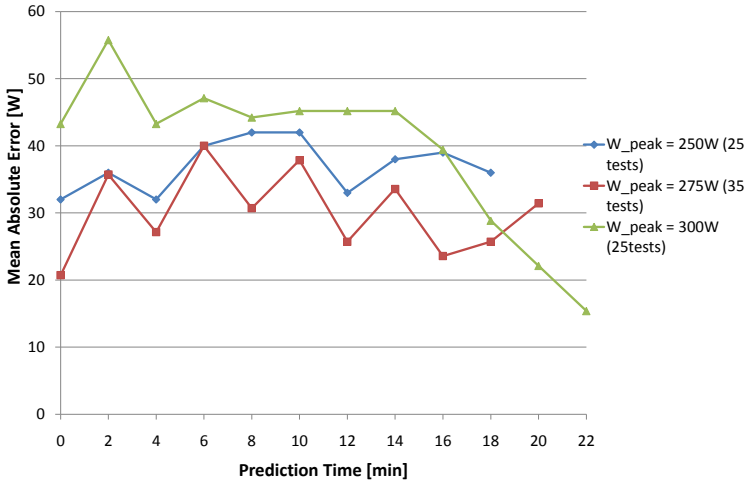


(a)

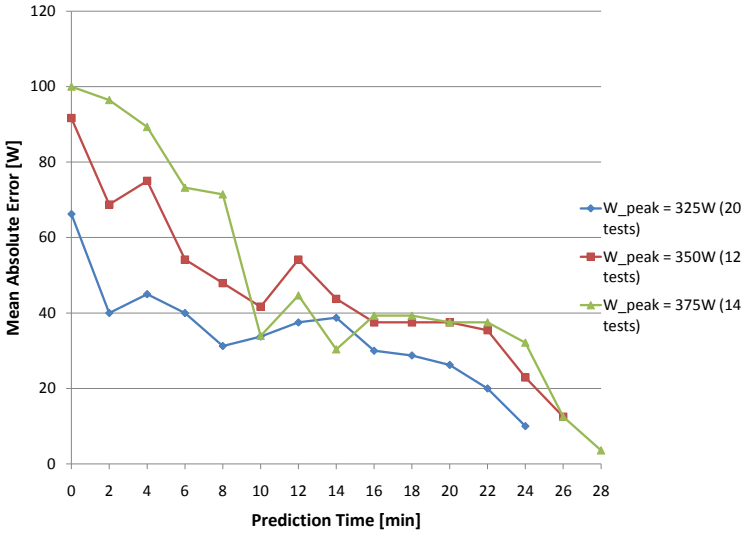


(b)

Fig. 6. Dataset $D_{25\times2}$: Setting 1 (*training cycles* = 500, *learning rate* = 0.3, *momentum* = 0.2 , *hidden layer* = 1)

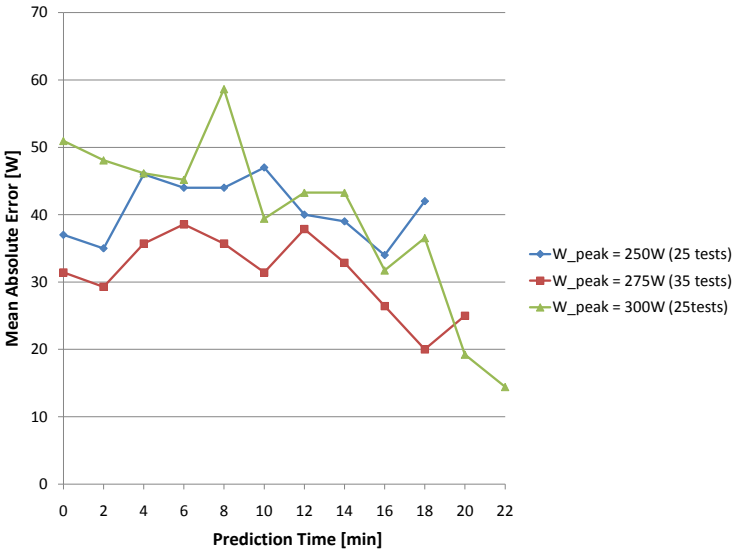


(a)

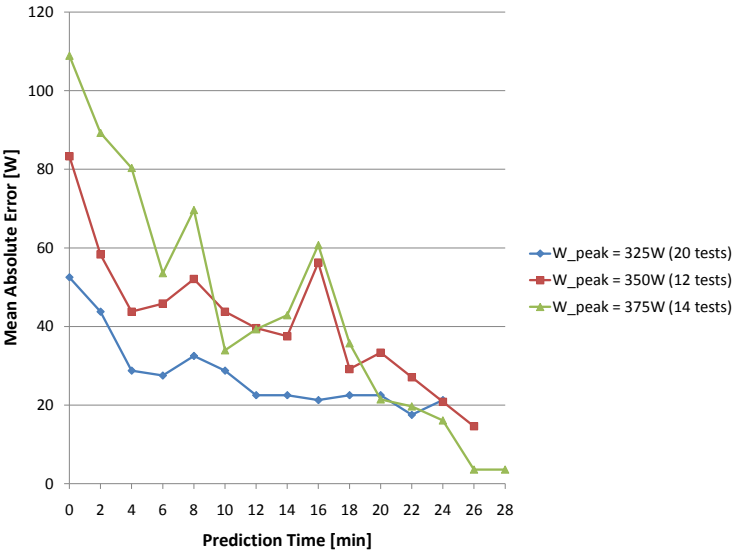


(b)

Fig. 7. Dataset $D_{25\times2}$: Setting 2 (*training cycles* = 500, *learning rate* = 0.3, *momentum* = 0.2 , *hidden layer* = 2)

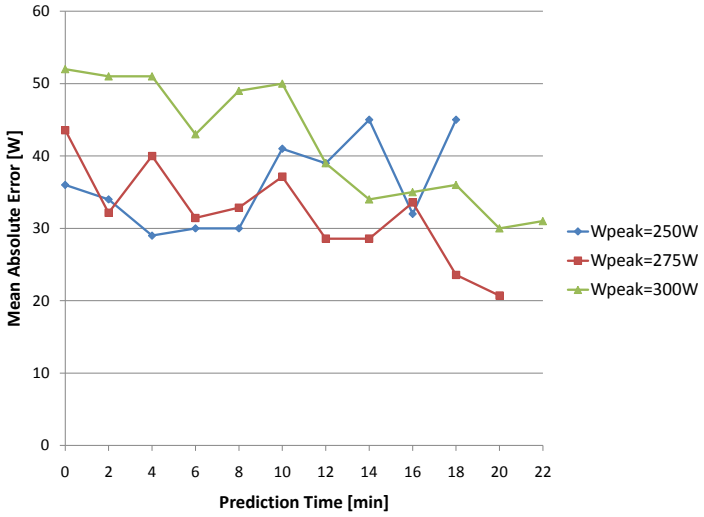


(a)

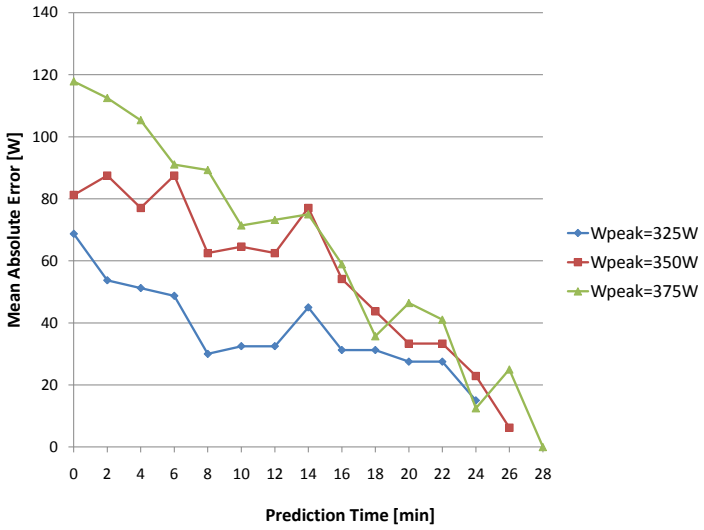


(b)

Fig. 8. Dataset $D_{25\times2}$: Setting 3 (*training cycles* = 500, *learning rate* = 0.2, *momentum* = 0.3 , *hidden layer* = 1)

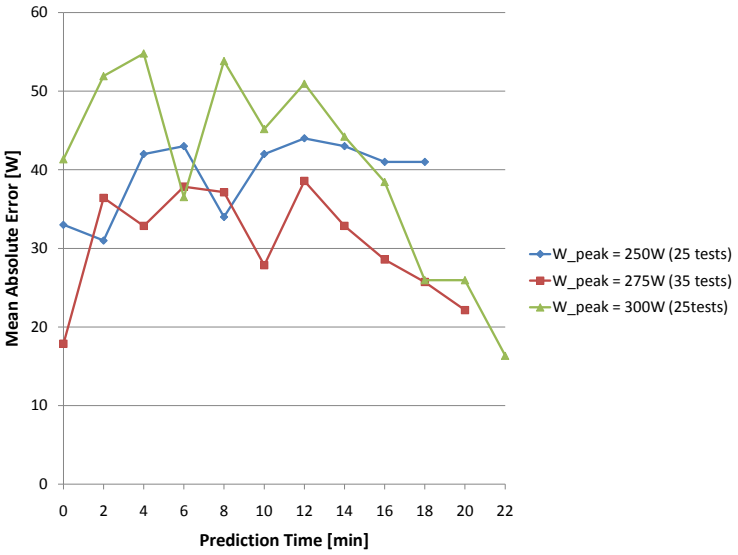


(a)

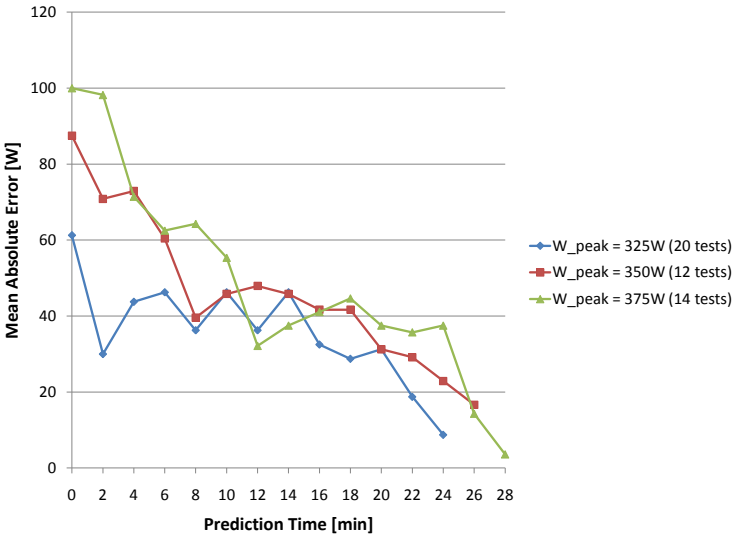


(b)

Fig. 9. Dataset $D_{25\times2}$: Setting 4 (*training cycles* = 500, *learning rate* = 0.2, *momentum* = 0.3 , *hidden layer* = 2)



(a)



(b)

Fig. 10. Dataset $D_{25\times2}$: Setting 5 (*training cycles* = 500, *learning rate* = 0.4, *momentum* = 0.2 , *hidden layer* = 2)