

## 10<sup>th</sup> Solar & Storage Integration Workshop

International Workshop on Integration  
of Solar Power and Storage into Power Systems

VIRTUAL  
EVENT!

5 Nov 2020



# BEST-FIT MACHINE LEARNING CLASSIFIER FOR EARLY-STAGE PHOTOVOLTAIC HOT-SPOTS DETECTION

***Mahmoud Dhimish, Nigel Schofield***

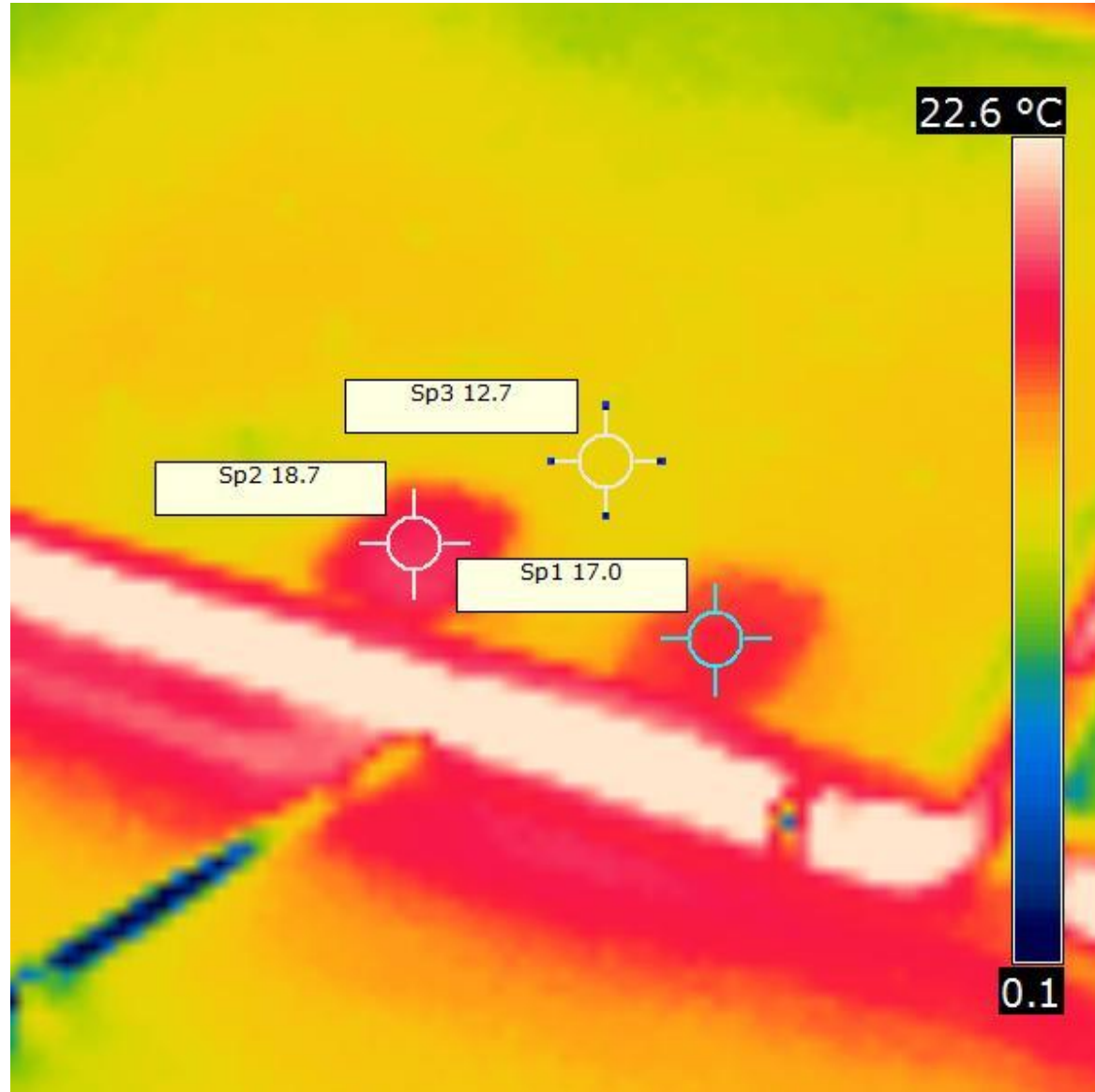
*Dept. of Engineering and Technology*

*University of Huddersfield*

*Huddersfield, United Kingdom*

# Background

- Photovoltaic (PV) modules reliability and durability became a vital determinant to utilise the leading cause of PV degradation, failure-rates, and mismatching conditions.
- Most reliable PV technologies in today's market are equipped with bypass diodes.
- PV Hot-Spots



Background

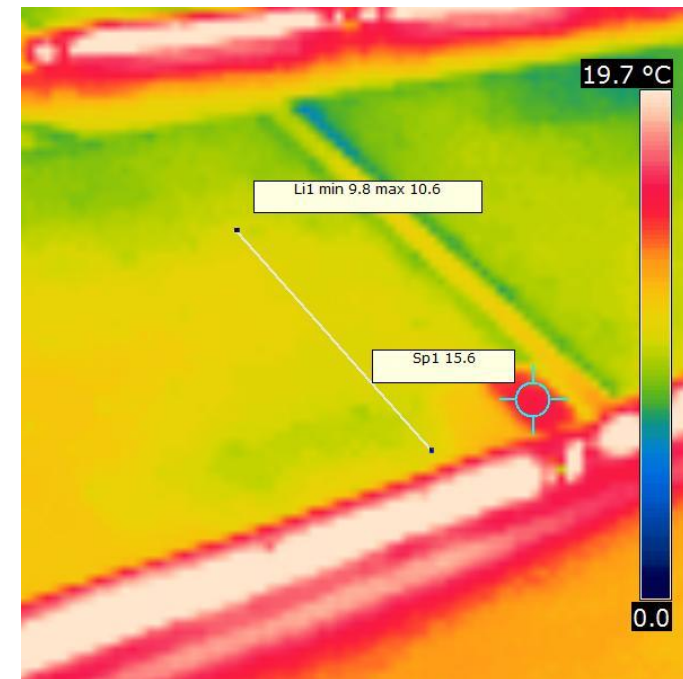
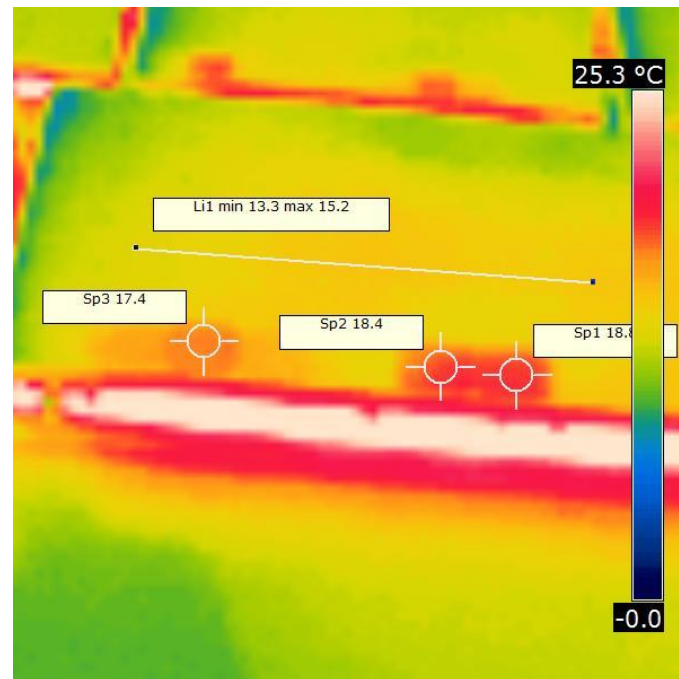
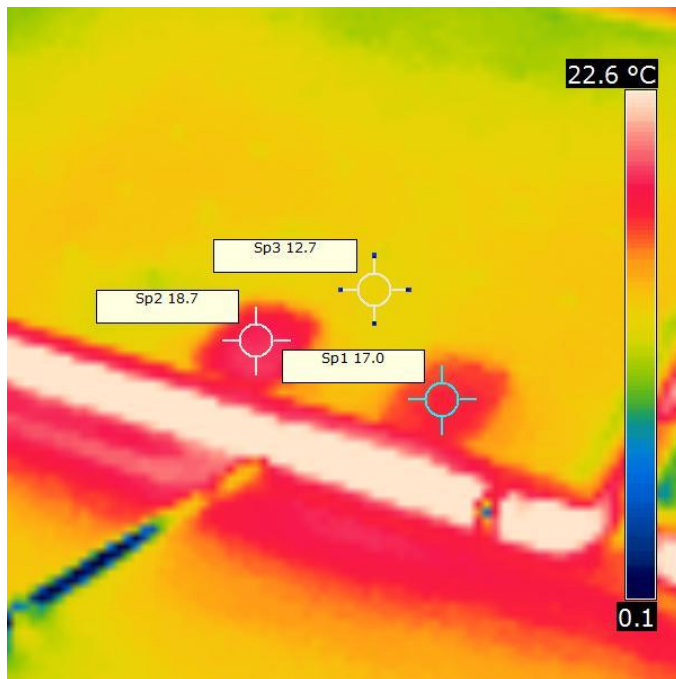
HOW CAN  
WE  
DETECT  
EARLY-  
STAGE  
HOT-  
SPOTS?





# EXAMINED PV SYSTEM



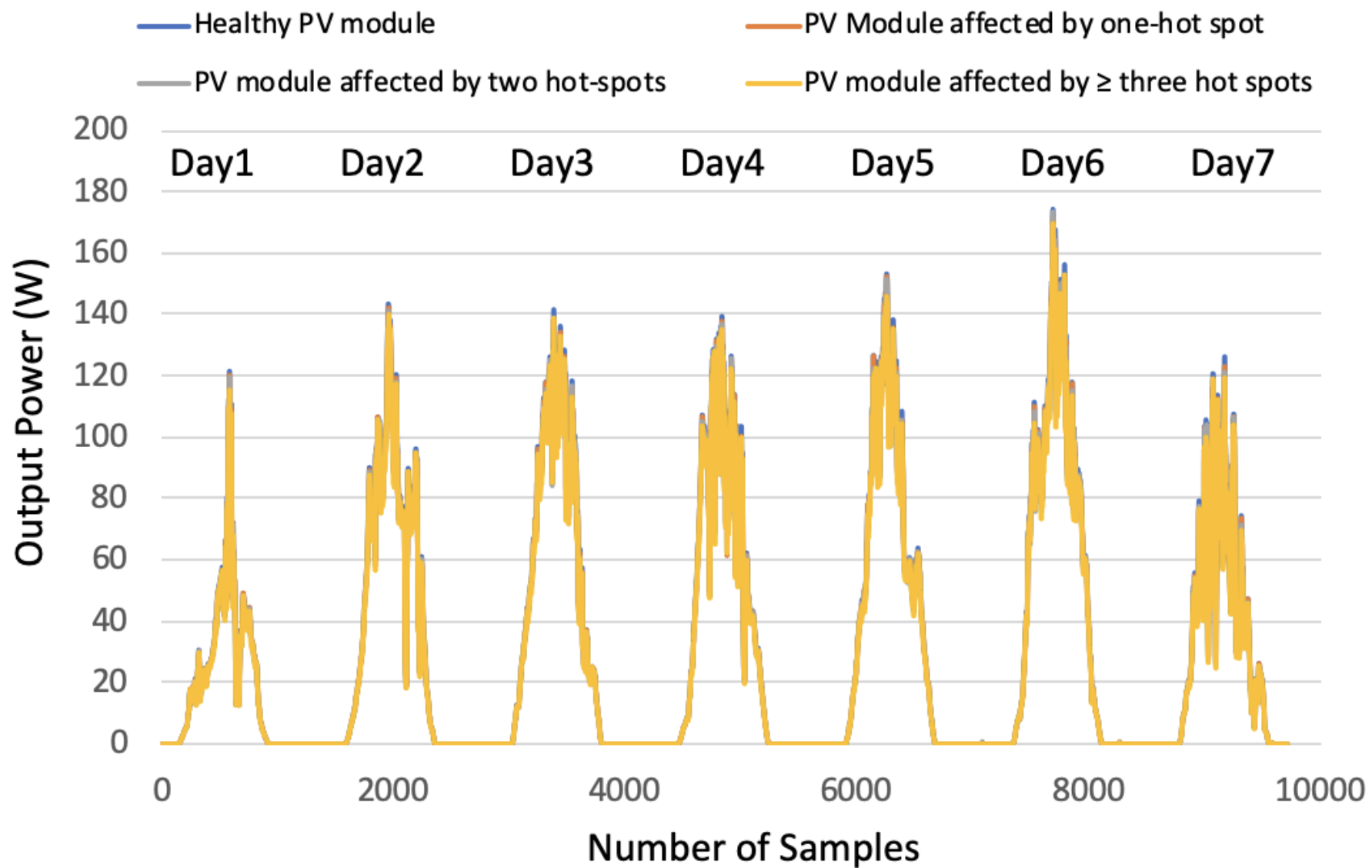


# HOT-SPOTS!

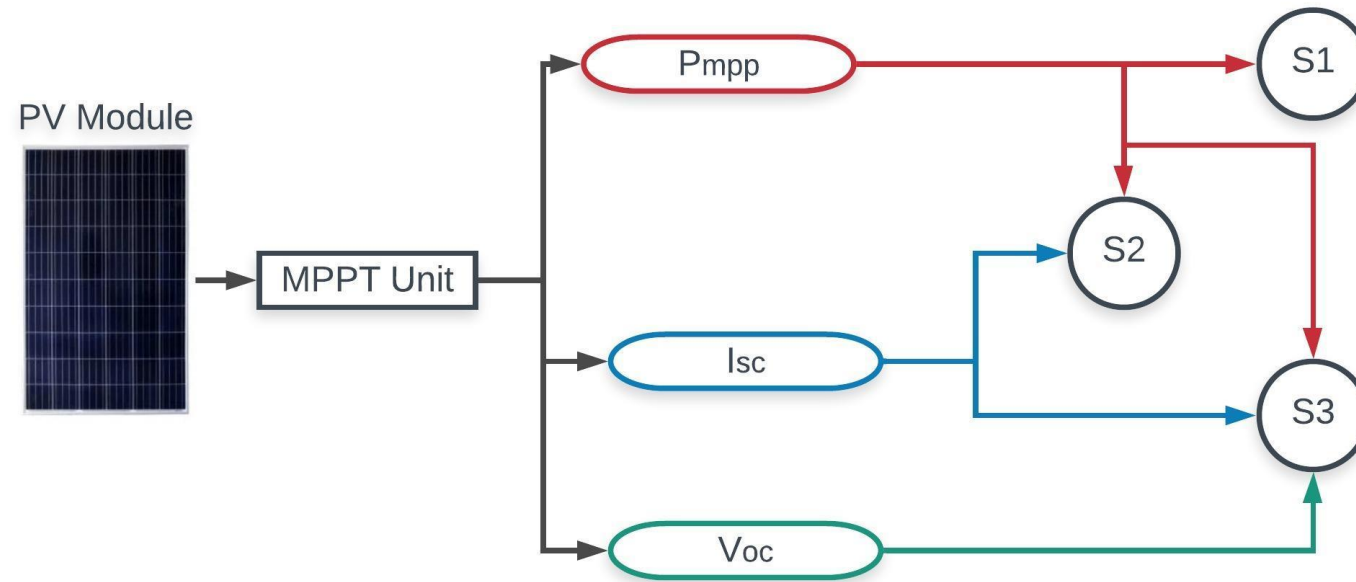


# Hot-Spots Categories

- 1) PV module affected by one hot-spotted solar cell*
- 2) PV module affected by two hot-spotted solar cells*
- 3) PV module affected by  $\geq$  three hot-spotted solar cells*

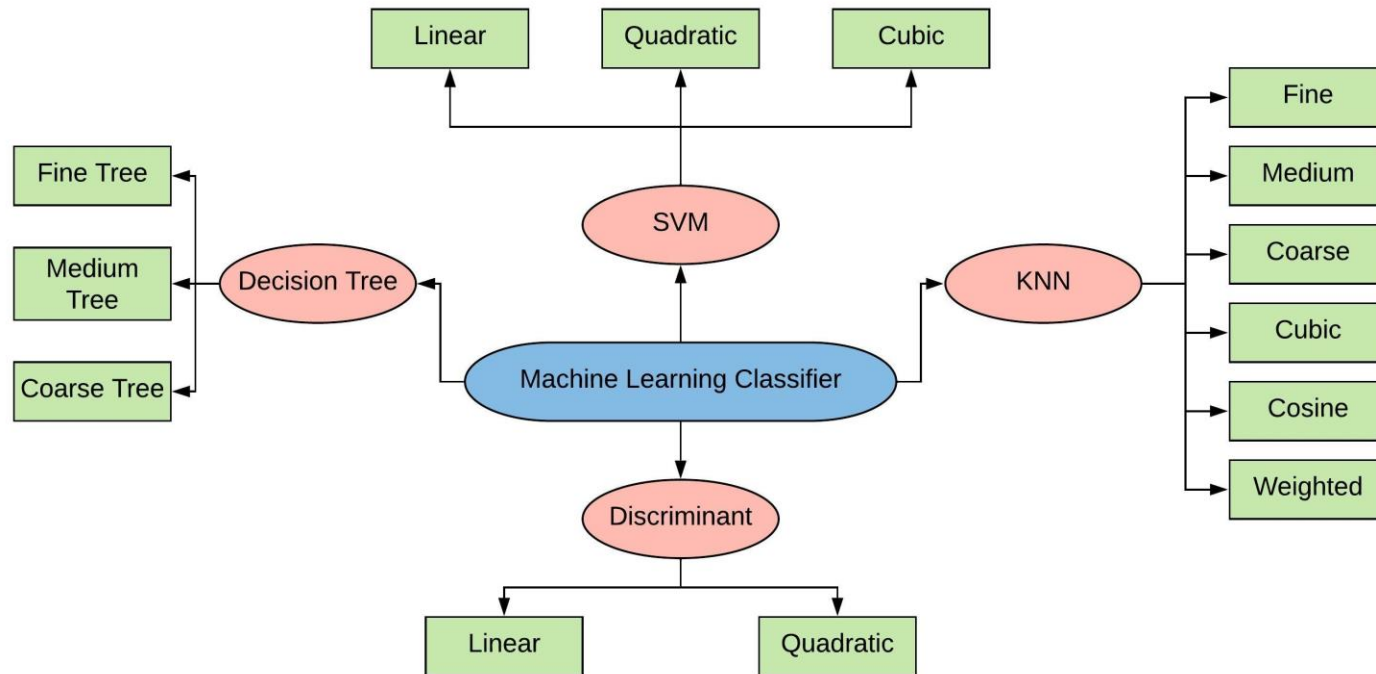




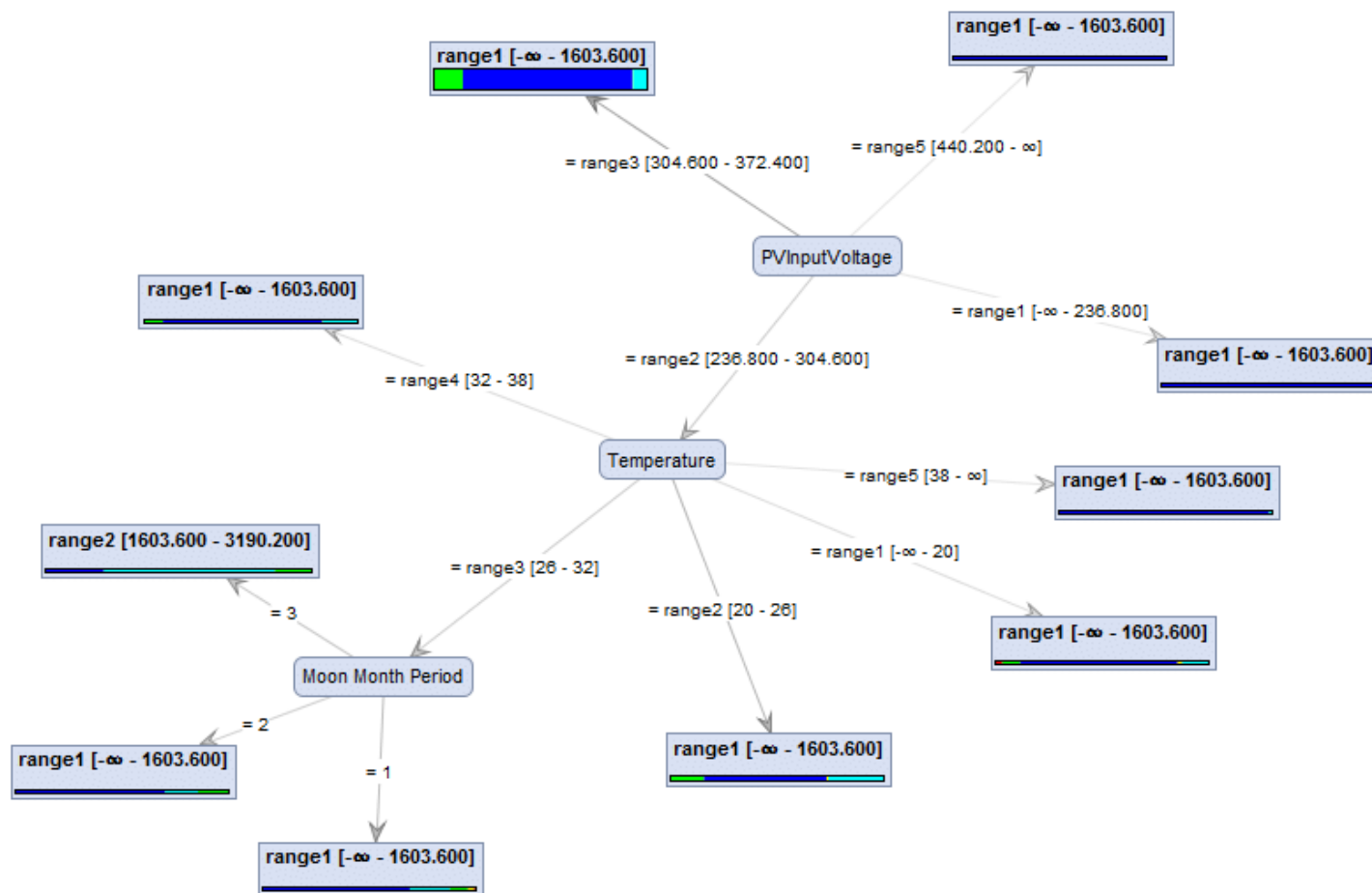


# PV PARAMETERS

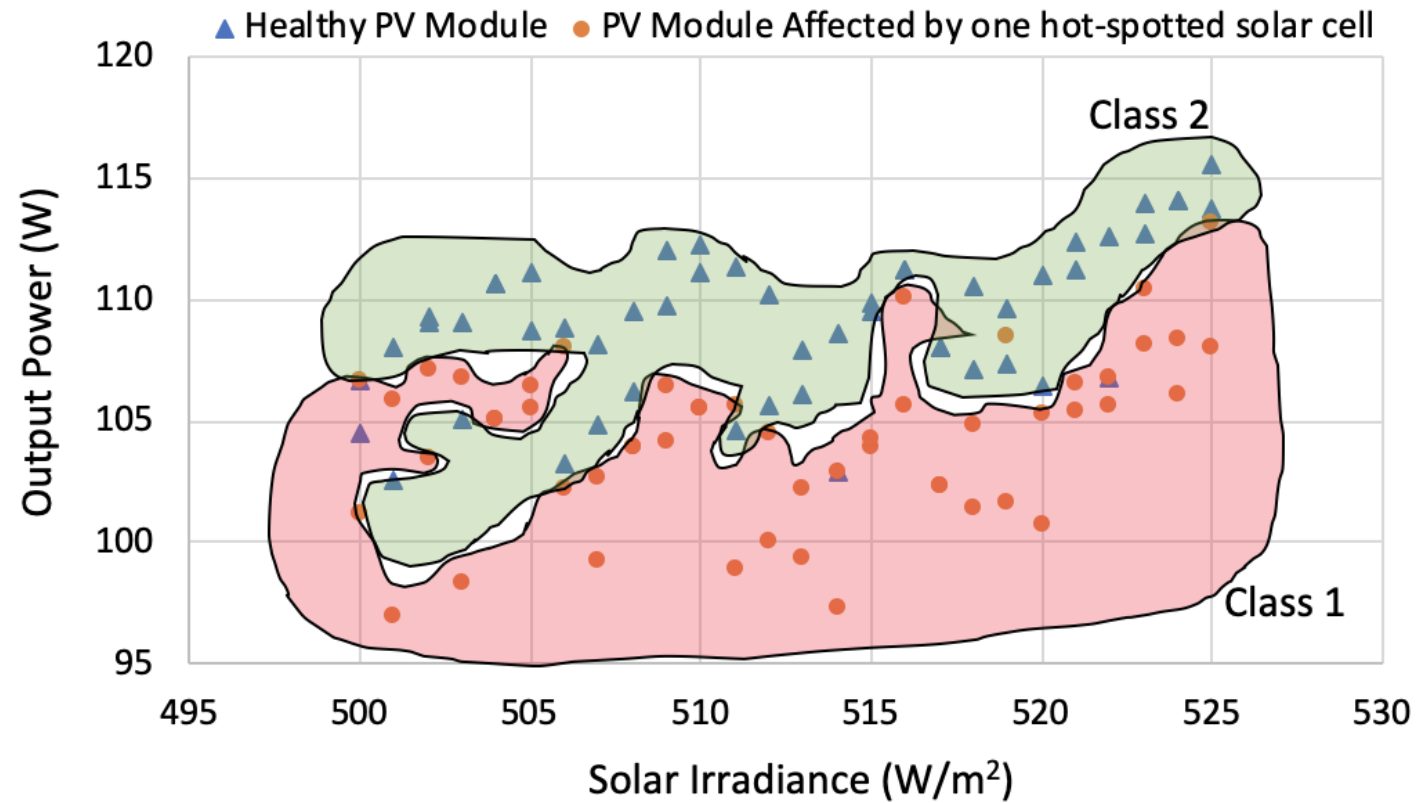




# MACHINE LEARNING TOOL

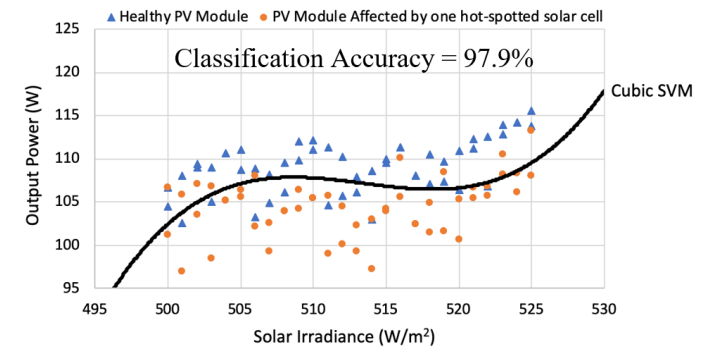
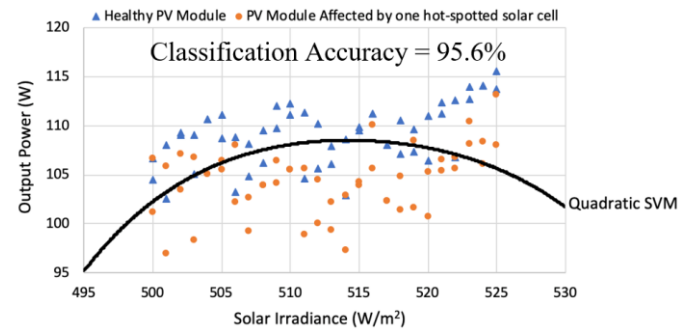
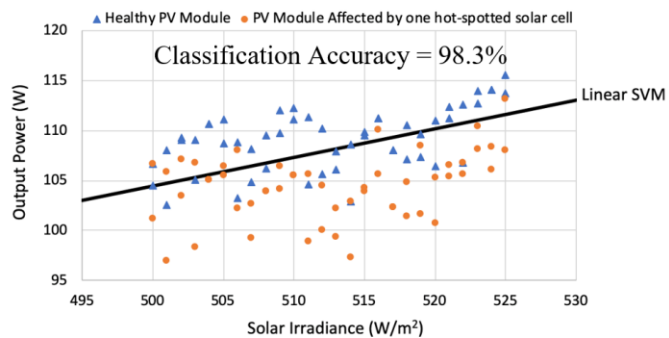


# DECISION TREE

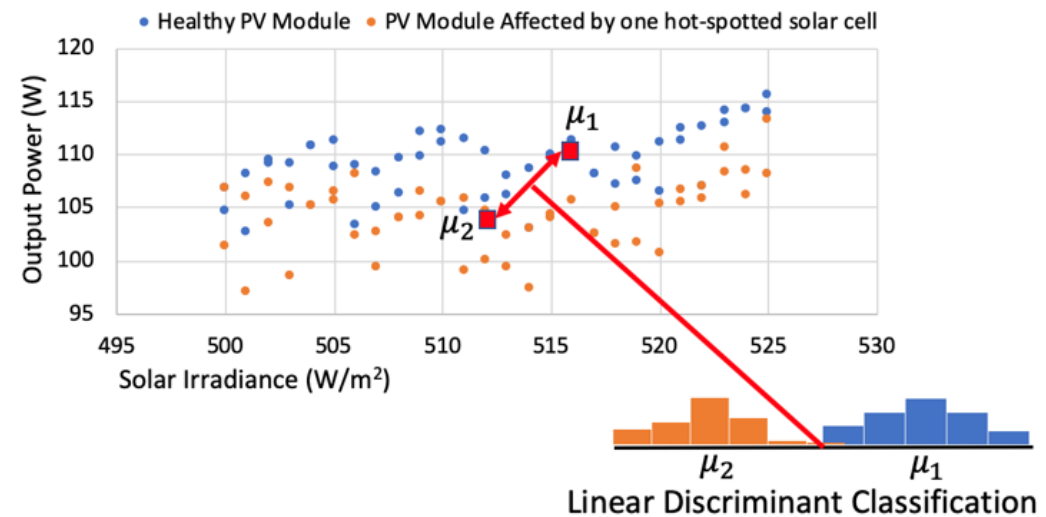
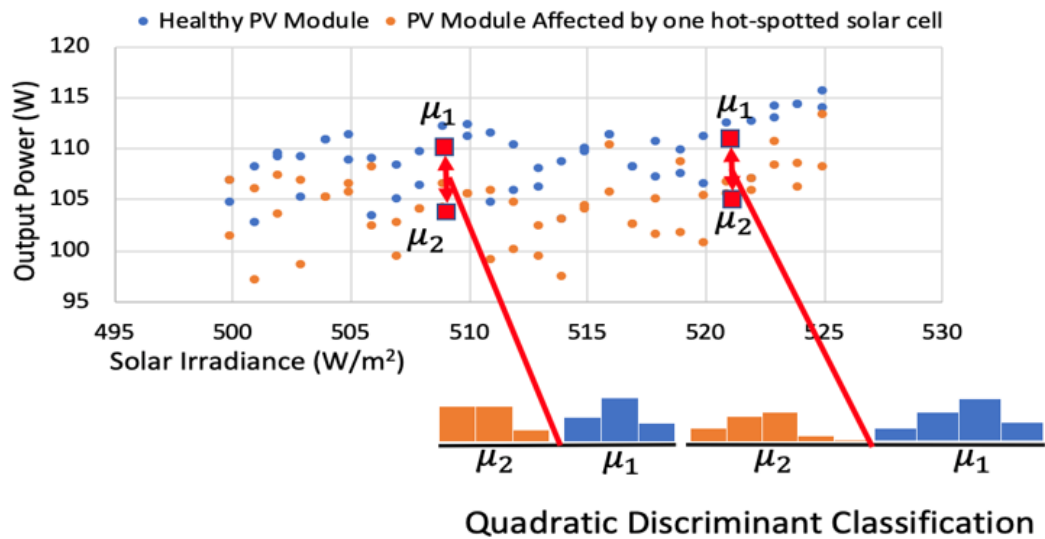


K-NEAREST  
NEIGHBOUR

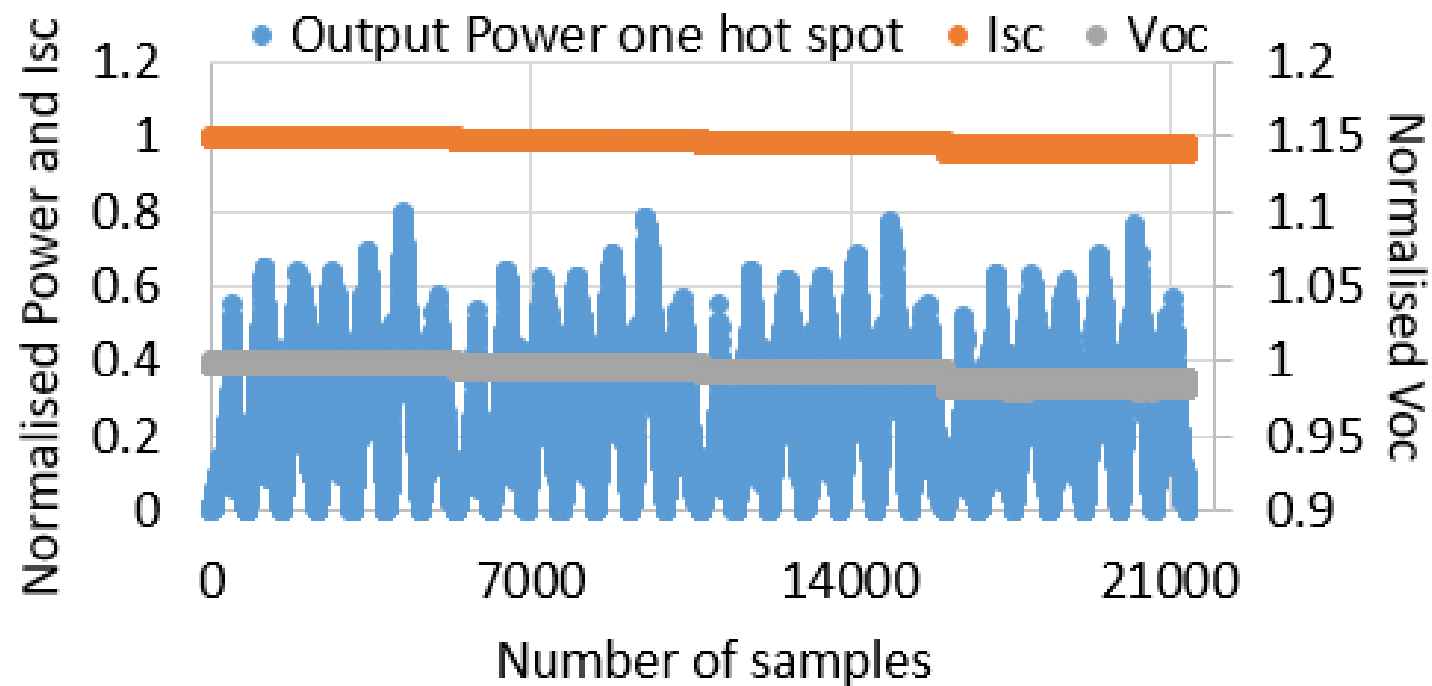
# SUPPORT VECTOR MACHINE



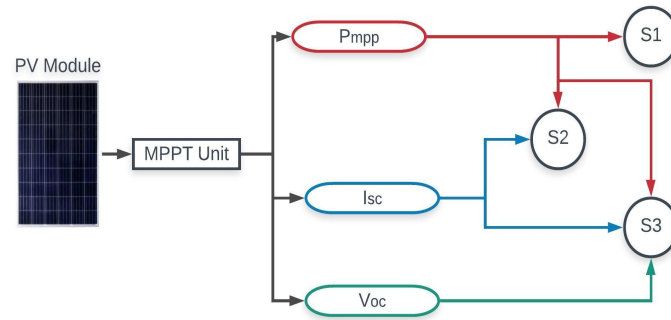




# DISCRIMINANT



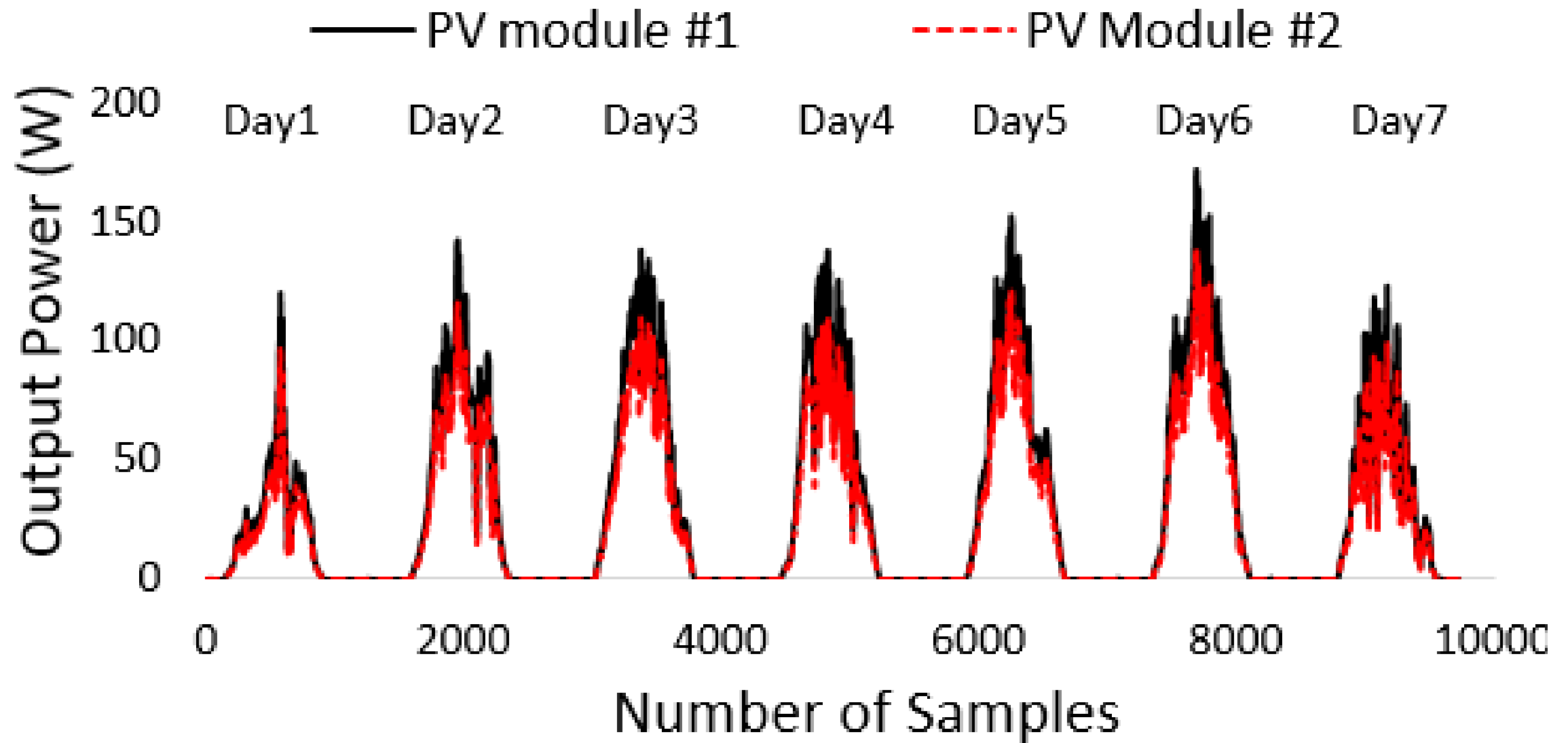
*TRAINING  
AND  
VALIDATION*



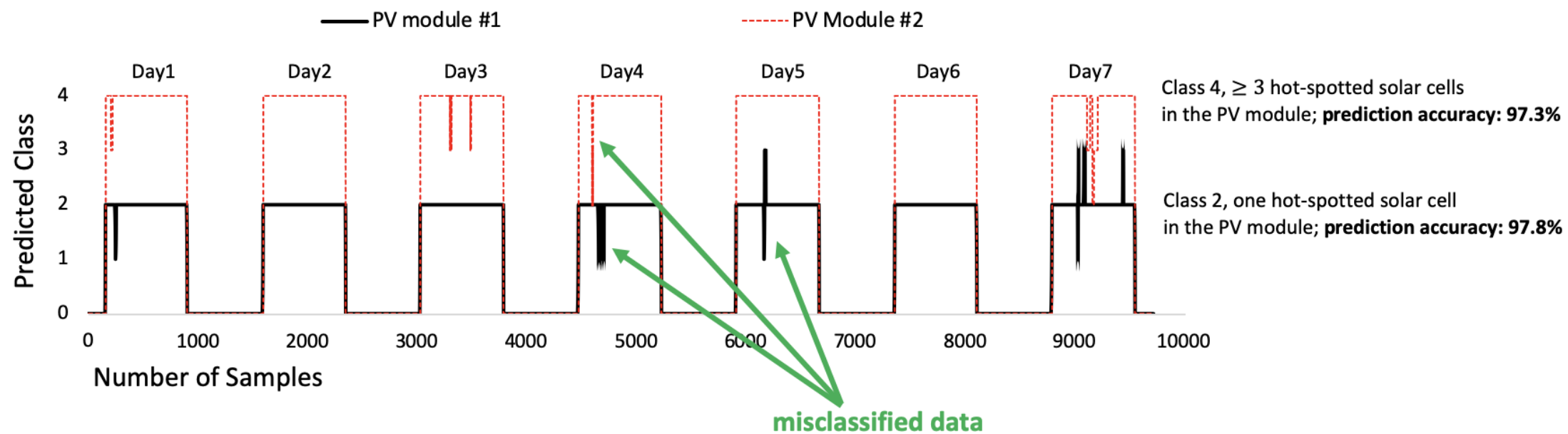
Classifier	Classification Algorithm	Accuracy (%) using data setup 1	Accuracy (%) using data setup 2	Accuracy (%) using data setup 3
DT	Fine	25	83	88
	Medium	27	87	91
	Coarse	26	80	84
SVM	Linear	44	79	93
	Quadratic	42	77	94
	Cubic	42	77	92
KNN	Fine	51	85	93
	Medium	54	86	94
	Coarse	43	86	94
	Cosine	49	77	86
	Cubic	56	87	97
	Weighted	52	86	96
Discriminant	Linear	49	87	95
	Quadratic	52	90	98

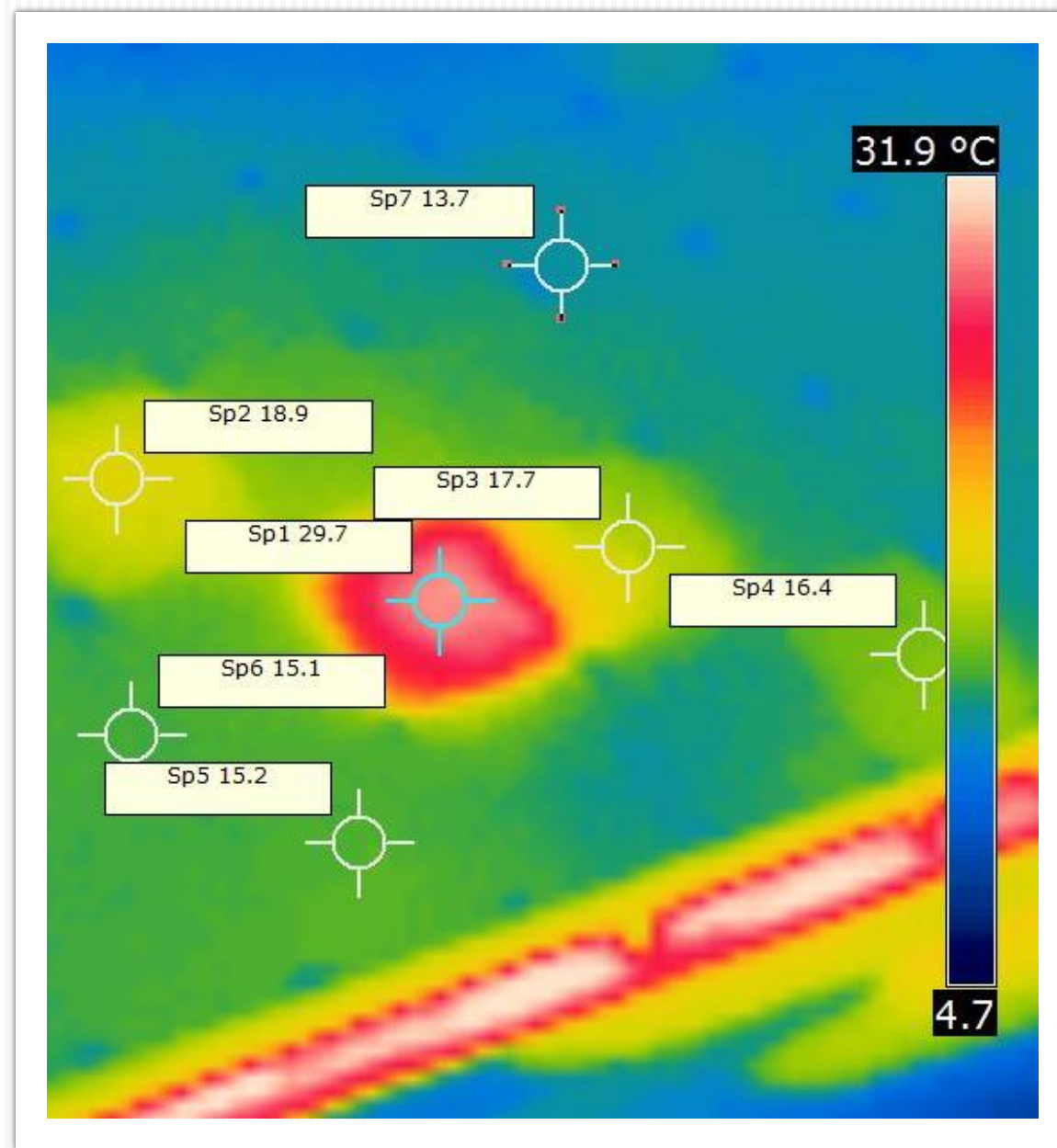
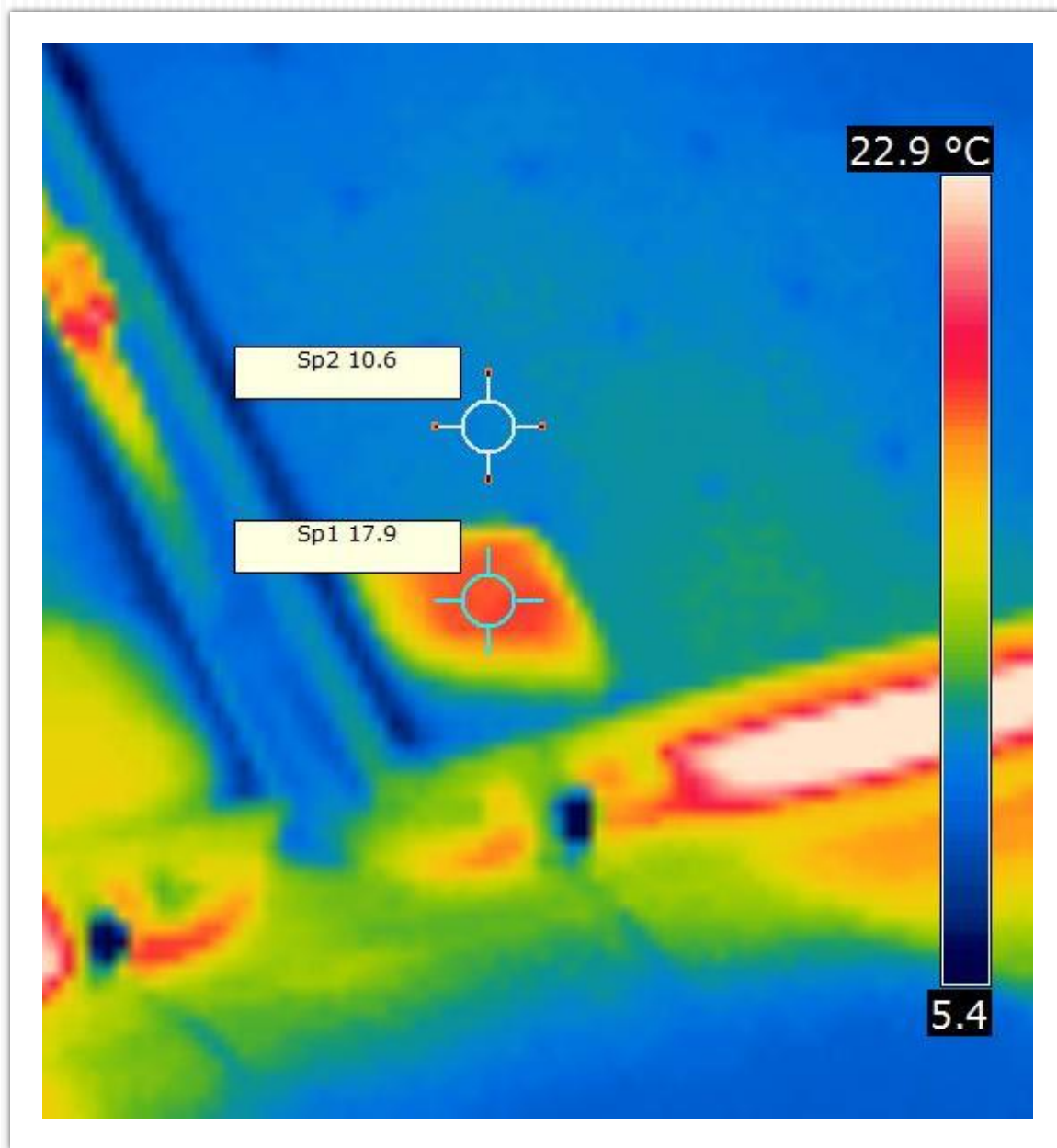


# PV TESTING









# Conclusion

In this study, the comparison of four different classifiers were obtained: classifiers including decision tree, support vector machine, K-nearest neighbour (KNN), and the discriminant classifier. It was observed using the data of several PV modules affected by hot-spots that quadratic discriminate classifier achieves the best accuracy of 98%, while the minimum determined accuracy of 84% was obtained for coarse decision tree. The accuracy of the quadratic discriminate classifier was also identified by examine two hot-spotted PV modules over a period of one week. On average, the accuracy to predict the type of the hot-spot in both PV modules was above 97%.



THANK YOU  
FOR YOUR  
ATTENTION!