GOAL OF THE LETTER: A 250-word submission cover letter is required for all research letters and research articles. The letter should explain why the submitted work is appropriate for *Optica*, which aspects of the work are novel, and how the work is important to the broader optics/photonics and scientific communities. The cover letter and manuscript abstract will be evaluated by at least two editorial board members to determine if the paper is approved for external peer review. Every effort will be made to complete this editorial review within seven business days of submission.

Dear Editors,

we wish to submit the new manuscript entitled: “Model-free dual oxygen and temperature luminescence sensor based on neural networks”, for consideration to be published in the journal Optica. We confirm that this work is original and has not been published elsewhere nor it is currently under consideration for publication elsewhere.

In this paper, we report research on a new approach that demonstrates the applicability of artificial intelligence, and in particular neural networks with multi-task learning architectures, to sensing technology, in particular to oxygen sensing, and paves the road for the next generation of sensors.

This work proposes a new revolutionary approach to multi-parameter determination in fluorescence using neural networks with multi-task learning architectures. The classical approach is to take a mathematical model describing the functional dependence of the dependent variable from a set of independent variables, and then, using non-linear fitting algorithms, extract the parameters used in the modeling. Particularly challenging are real systems, characterized by several additional influencing factors related to specific components, like electronics or optical parts. In such cases, to make the model reproduce the data, empirically determined terms are built in the models to compensate for the impossibility of modeling things that are, by construction, impossible to model.

Our approach allows us to determine multiple parameters with a completely model-free approach. In this paper we show that, without the need of any *a priori* mathematical model, this approach reach the accuracy of commercial sensors. Not only that, but the described approach is able for the first time to determine the oxygen concentration and the temperature at the same time from a single set of fluorescence measurements. This is not possible in classical sensors, where the temperature needs to be determined separately by a second measurement process. In this paper a new metric that can be used to characterize a sensor that is based on neural networks is described, allowing its characterization in a way that was not possible before.

Furthermore, the proposed approach is not limited to oxygen and temperature sensing but can be applied to the luminescence of multiple luminophores, whenever the underlying mathematical model is not known or too complex to derive the desired quantities from a single measurement.

All authors listed have contributed sufficiently to the project to be included as authors, and all those who are qualified to be authors are listed in the author byline. To the best of our knowledge, no conflict of interest, financial or other, exists.

Sincerely,

Prof. Dr. Francesca Venturini

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