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Interactive comment on "Multi-source data integration for soil mapping using deep learning" *by* Alexandre M. J.-C. Wadoux et al.

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Dear authors,

Your paper brings forward two important subjects for the DSM community, namely contextual mapping and measurement error integration. The use of convolutional neural networks for DSM is compelling, in particular with a single model predicting a soil property at different depths. However, the methodology in your manuscript needs improvement. The different concepts have to be defined and described in a clear way even though they are complex, especially since deep learning has only been applied in a few DSM papers. Below are comments on the methodology part.

First, concerning the Artificial Neural Networks section:

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Discussion paper

a. Each layer contains units: nodes for the input layer (as no computation occurs at their level) and neurons for the hidden and output layers;

b. You should avoid confusion on the term “model parameters” right in this ANN section. Further in the case study part (3.2.2 Parameter estimation), you make the difference between model parameters and “the hyperparameters of the model architecture”: these should be clearly defined before. I would first consider that the model parameters are the numbers of hidden layers, hidden neurons and iterations (i.e. parameters of the model architecture), not the connection weights and bias. You need to clarify this.

c. You use the abbreviation ReLU (for Rectified Linear Unit): you should clarify it and shortly explain it (giving the equation is not enough).

d. Equations 3 to 5 are not self-sufficient; you need to introduce them more. Particularly, you start by writing “For k = 1, . . ., L hidden layers,”, but h0 is for the input layer and hL for the output layer. You have to modify Figure 1 accordingly as well.

Second, concerning the Convolutional Neural Networks section:

a. You should refer more to your figure 1 and list shortly the different steps or layers of a CNN before describing them one by one.

b. Define the word convolution straight ahead (i.e. element-wise product and sum between two matrices), this is a new concept for most in the DSM community.

c. You use the Max-pooling operator and should define it simply (i.e. selecting the maximum value in the convoluted image using a window size). For now, we only read the term in table 1.

d. You should clarify what you mean by “the number of channels (aka depth)”: Which depth are you referring to?

e. You do not define the flatten operation as such, only writing that “. . .the last convolution returns an image of size 1 x 1 and with a number of channels. This is a vector

that we can pass to a fully connected layer." Again, we only read the term in table 1.

f. You should state clearly that a fully-connected layer is an ANN. For now, it is only noted in figure 1′s caption.

g. You neither define the dropout operation. It should be in the methodology.

Third, concerning the parameter estimation:

a. You define the dataset D as ". . . a 4-D matrix of size n x c w x h . . .", but you only defined n (i.e. the number of calibration points) much later in the paper.

b. You have to be clear and consistent when you use the term "weights" (in this section and the whole paper): the measurement error weights (defined in the 2.5 section) are different from the connection weights (as in the model parameters theta). Using only the term "weights" is confusing.

c. It is important that you describe shortly the Bayesian optimization here and not in the case study part (3.2.2 Parameter estimation);

d. You should also clarify the backpropagation concept in connection with the error gradient descent. These are crucial points for neural networks in general.

You can also find a few more comments on your manuscript in the attached file.

Please also note the supplement to this comment:
https://www.soil-discuss.net/soil-2018-39/soil-2018-39-SC1-supplement.pdf

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