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Analyze Soil Fertility using Deep Learning Convolutional Neural Networks

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Abstract
This research revolves around how plant soil potential can be further discovered and used for farming through detection of relevant nutrients and chemicals within the soil landscapes within areas and even desert climates and how we can improve land soil fertility of the purpose of farming both using Convolutional neural networks which process of imagery in layers and predictive detections of objects within image backgrounds and frontal lobes.
When we view layers for farming beneath the surface to understand suitability of farming done on top. The general model applied can be summarized as follows:
As shown In Appendix 1a, we can see the various layers soil has to assess the possibility of nutrient provision for farming [2].
The Objective is to examine availability of plant nutrients using convolution of Nueral networks to classify open farmlands through image analysis and layering.
Convolution Nueral networks is divided into four steps starting with input of images, drafting a convolution layer, creating a pooling layer and flattening the Nueral network. It can be performed as a machine learning Algorithmic procedure with Python as well as R programming.
CNN divides the images into pixels, edges, frontal lobes and shading through the support of power machine learning libraries and packages like Tensorflow and Keras.
Keywords: Convolutional Nueral Networks, Soil Fertility, Deep Learning, Computational Power.

Introduction

This article guides a stepwise walk through by Experts for writing a successful journal or a research paper starting from inception of ideas till their publications.

Background

Soil fertility examines the potential for any land for farming purposes and it varies by climate and equator region in terms soil erosion. As we know Convolutional Nueral networks work in image sequence processing through parameters for image adjustment and pixel detections.

Some researchers prefer the use of complex computing methodologies to analyze layer of soil fertility, while others prefer simple objective statistical models to analyze evidence of soil nutrition. To identify minerals for the potential of farming within soil we must conduct mineral assessments using layered image analysis to calculate the statistical significance of soil fertility being high or low within a designed farming space.

Literature Review

Research on "Machine Learning Strategy for Soil Nutrients Prediction Using Spectroscopic Method" by MDPI, Janez Trontelj ml. and Olga Chambers *(2021) assessed various machine learning methods to use for analyzing soil nutrition. Where Nueral networks are shown to account for all volatility within small dataset changes which can be a frequent case in soil fertility as erosions and landscape disruptions can erode the possibility of growing crops on land. Thus, convolution Nueral networks for image analysis will also account for small data changes to landscape.

Modeling the Spatial Distribution of Soil Nitrogen Content at Smallholder Maize Farms(Appendix 1b) Using Machine Learning Regression and Sentinel-2 Data by George Chirima (2021) has analyzed that nitrogen is one the essential KPI's that provide indication of soil quality and the fertility potential of the soil to grow plants and crops and Three ML algorithms had investigated predictability of soil nitrogen content which included Random Forest, Gradient Boosting (GB) and Xtreme gradient boosting and they all provided results between 0.8 – 0.9 in terms of R2 but no method was utilized for digital mapping of Nitrogen contents on farm lands, Which Convolutional Nueral networks could display the POC for further implementation.

Analysis on soil properties by various scholars inclusive of Tomislav Hengl, Matthew A. E. Miller, Josip Križan, Keith D. Shepherd, Andrew Sila, Milan Kilibarda, Ognjen Antonijević, Luka Glušica, Achim Dobermann, Stephan M. Haefele, Steve P. McGrath, Gifty E. Acquah, Jamie Collinson,LeandroParente, Mohammadreza Sheykhmousa, Kazuki Saito, Jean-Martial Johnson, Jordan Chamberlin, Francis B. T. Silatsa, Martin Yemefack, John Wendt, Robert A. MacMillan, Ichsani Wheeler & Jonathan Crouch (2021) in regards to African soil properties and nutrients mapped at 30 m spatial resolution using two-scale ensemble machine learning has shown predictions produces for availability of nutrients in farmlands in regards to required inputs of Carbon, nitrogen calcium, potassium, magnesium, Sulfur etc. along with bulk density and depth to bedrock which would be ideal to analyze crop fertility on lands. It showed varying accuracy per input prediction between intervals of 0.8 to 0.9 but this was possible due to assistance in collecting data from NGOs and governments.

Daniel Tran, Fabien Dutoit, Elena Najdenovska, Nigel Wallbridge, Carrol Plummer, Marco Mazza, Laura Elena Raileanu & Cédric Camps had conducted Electrophysiological assessment of plant status outside a Faraday cage using supervised machine learning. Which enabled real time electric signal measurements for data collection in assisting with predictability on imaging for crop nutrients which is similar to the approach by Tomislav Hengl, Matthew A. E. Miller, Josip Križan, Keith D. Shepherd, Andrew Sila, Milan Kilibarda, Ognjen Antonijević, Luka Glušica, Achim Dobermann, Stephan M. Haefele, Steve P. McGrath, Gifty E. Acquah, Jamie Collinson, Leandro Parente, Mohammadreza Sheykhmousa, Kazuki Saito, Jean-Martial Johnson, Jordan Chamberlin, Francis B. T. Silatsa, Martin Yemefack, John Wendt, Robert A. MacMillan, Ichsani Wheeler & Jonathan Crouch (2019) in regards to how African soil properties and nutrients are mapped on spatial resolution machine learning algorithms but it uses Regression algorithms instead on ensemble based and made predictions using electric signal data instead of layered imagery and showed relatively lower accuracy rates between 70% to 85%.

Applying Analytics on land mapping with the help of Google Earth Engine by Bakhtiar Feizizadeh, Davoud Omarzadeh, Mohammad Kazemi Garajeh, Tobia Lakes & Thomas Blaschke (2021) through the use of Machine learning data-driven approaches for land use/cover mapping and trend analysis using Google Earth Engine where SVM, RFC and RFR were applied on image time series data had yielded accuracies between which SVM took the lead by an accuracy above 90% in all series of data frames between the years 2000 and 2020 showing crop fertility can be predicted best with Support vector machine algorithms in assumption of the data being Image time series based.

An Experiment was conducted by Lucas Benedet, Salvador F.Acuña-Guzman, Wilson MissinaFaria, Sérgio Henrique Godinho Silva, Marcelo Mancini, Anita Fernanda dos Santos Teixeira, Luiza Maria Pereira Pierangeli, Fausto Weimar Acerbi Júnior, Lucas Rezende Gomide, Alceu, Linares Pádua Júnior, Igor Alexandre deSouza, Michele Duartede Menezes, João José Marquesa, Luiz Roberto Guimarães Guilherme and Nilton Curi (2019) on Rapid soil fertility prediction using X-ray fluorescence data and machine learning algorithms.

In this experiment X-ray fluorescence data is used for analysis in layering imagery to find hidden nutrients which is a similar methodological approach like CNN (Appendix 1a) but relies on dividing an image into layers for further study, whereas CNN can select anomalies in any series of images before layering the images. Rapid soil fertility prediction using X-ray fluorescence data was tested with the best performance in RF algorithms showing how tree probabilities might affect outcomes of prediction when analyzing image objects. The validation R2 values had ranged from 0.59 to 0.82.

Research and analysis by Gerald Forkuor ,Ozias K. L. Hounkpatin, Gerhard Welp, Michael Thiel (2017) on High Resolution Mapping of Soil Properties Using Remote Sensing Variables in South-Western Burkina Faso. can provide a consequential comparison of how trying to make predictive analytical classification using Satellite data including imagery of Remote sensing technologies encoded in high spatial resolutions such as Rapid Eye and Landsat. It is Similar to Crop classification analytics by using land mapping with the help of Google Earth Engine by Bakhtiar Feizizadeh, Davoud Omarzadeh, Mohammad Kazemi Garajeh, Tobia Lakes & Thomas Blaschke, there were also three supervised ML algorithms used including SVM, SGB and RF. Six soil properties compromising of sand, silt, clay, CEC, SOC and Nitrogen were analyzed in imagery to find crop fertility based on density and insights showed that RF ML algorithms had more accurately detected extrapolated crop land covers than MLR in predicting soil properties present. Which may tend to prove that layered imaging like CNN may provide separate frames of analysis to diagnose complex bedrock structures beneath crop plantations to provide a more accurate visual overview.

Sneha Bandyopadhyay, Subodh Kumar Maiti (2021) research on Statistical modelling approach on prediction of Soil quality used MLR and RF based ML algorithms as predictor variables against RMSQI as the base variable for soil quality assessment in a post mining site in India. It was analyzed within the research that parameters highly influencing soil were;

- Organic carbon.
- Exchangeable potassium.
- Cation exchange capacity.
- Sand percentage.
- Microbial biomass carbon.
- Dehydrogenase activity.
- Fluorescein diacetate

Wartini Ng, Budiman Minasny, Maryam Montazerolghaem, Jose Padarian, Richard Ferguson, Scarlett Bailey, Alex B.McBratney (2019) has analyzed with their research on testing CNN on prediction of soil properties through feeding spectral data to algorithms, where 75% of the data was used for training and the remaining was used for testing. CNN in this experiment was identified as a superior algorithm over PLSR and Cubist Tree models by an improved accuracy of 33-42% in benchmark against PLSR and 22% to 36% when benchmarked against Cubist Tree.

During the international Joint Conference on Nueral Networks a use case applying CNN on Tomato Crop Images for classifying deficiency was presented by Claudio Cevallos, Hiram Ponce, Ernesto Moya-Albor and Jorge Brieva (2020), Where various images of Tomato plants were fed into CNN algorithms each showing different symptoms of nutrient deficiency and the experiment model had shown to achieve an 86.67% accuracy with CNN based algorithms on Crop Imaging.

Conclusion & Discussion

In further review of all research analyzed, it's possible to evidently view that majority of research and application done towards layered imaging in trying to separate layers of structures to discover minerals and fertility rates have mostly been applied using supervised machine learning algorithms in combination with Computer vision methodologies such as CNN and OpenCV but not much research have tried in applying Unsupervised machine learning algorithms thus most studies are limited towards use of constant assumptions towards their analytics in soil fertility and kept statistical sampling very restricted in certain localities rather than a general trend overview towards how soil fertility is impacted and changed which affects potential for crop farming as well as other forms of farming on it.

CNN analytics with soil fertility data might be the first phase of trying to discover the schematics of components fertility of soil to further assess using principal component analysis and apply clustering algorithms to visualize how minerals and land structures may be possessing a statistically significant relationship leading towards a predictable CNN model of Soil fertility in new farmlands. As shown in the research by Claudio Cevallos, Hiram Ponce, Ernesto Moya-Albor and Jorge Brieva (2020) CNN does yield high accuracy when it comes to anomaly detections in sets of imagery.

Here comes the most crucial step for your research publication. Ensure the drafted journal is critically reviewed by your peers or

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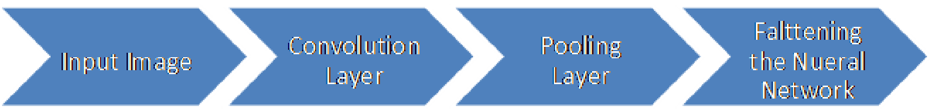
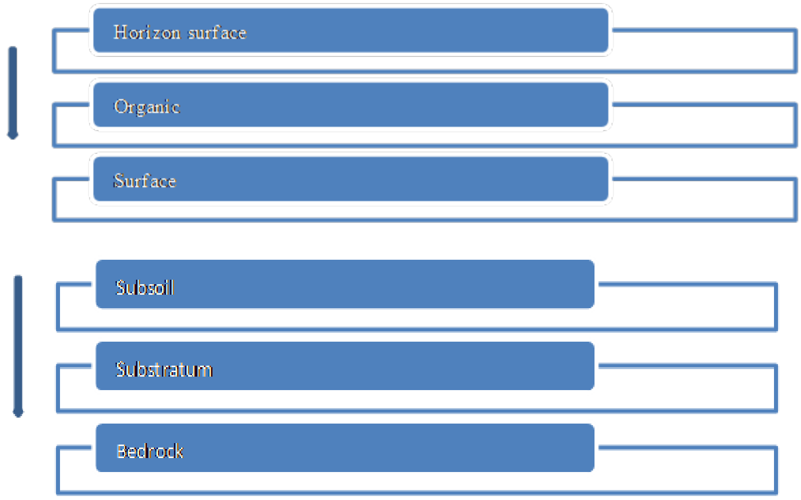
Appendicies

Appendix 1 a: CNN Flow Chart



Appendix 1 b Soil Fertility Process Chart



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