Deep Learning in Agriculture - what’s happening

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System of input and output: simplified
System of input and output: simplified

Stimulus

- Temperature
- Water
- Solar radiation
- Soil prop.
- ....

Response

Yield
Temperature
Solar radiation
Precipitation
Humidity
...

Soil properties
Soil type
Mineral content (N,P,K,..)
Organic content
Moisture
...

Weather
Irrigation
Fertilizers
Compost
Herbicides
...

Intervention
Temperature
Solar radiation
Precipitation
Humidity
...
Soil properties
Soil type
Mineral content (N,P,K,..)
Organic content
Moisture
...
Weather
Remote Sensing
Artificial Intelligence
Intervention
Irrigation
Fertilizers
Compost
Herbicides
...
IEEEExplore

Documents by year

Scopus

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("machine learning" OR "deep learning" OR "artificial intelligence" OR "neural network") AND ("agriculture")
Machine Learning

Deep Learning

CNN (Convolutional Neural Networks)

Sensor Data → Artificial Intelligence Methods → Agronomy

Temperature
Solar radiation
Precipitation
Humidity
...

Irrigation
Fertilizers
Compost
Herbicides
...

Soil type
Mineral content (N, P, K, ...)
Organic content
Moisture
...

Remote sensing image data

Agriculture information processing
Agriculture production system optimal control
Smart agriculture machinery equipment
Agricultural economic system management

https://granular.ag/farm-management-software/
Soil type
Mineral content (N,P,K,..)
Organic content
Moisture
...

Irrigation
Fertilizers
Compost
Herbicides
...

Temperature
Solar radiation
Precipitation
Humidity
...

Remote sensing
Image data

Sensor Data → Artificial Intelligence Methods → Subject areas

Machine Learning

Deep Learning

CNN
(Convolutional Neural Networks)

Plant
Animal
Land
Mechanization

Subject areas
Sensor Data → Artificial Intelligence Methods → Subject areas

Machine Learning

Deep Learning

CNN (Convolutional Neural Networks)

Remote sensing image data
- Hyperspectral
- Multi-spectral
- SAR
- Infrared/Thermal
- LIDAR
- NIR
- Optical
- X-ray

Sensor Data:
- Temperature
- Solar radiation
- Precipitation
- Humidity
- Irrigation
- Fertilizers
- Compost
- Herbicides
- Soil type
- Mineral content (N,P,K,...)
- Organic content
- Moisture

Subject areas:
- Crop classification
- Phenology recognition
- Disease detection
- Weed/pest detection
- Fruit counting
- Yield prediction

Plant
- Animal
- Land
- Mech.
- Crop classification
- Phenology recognition
- Disease detection
- Weed/pest detection
- Fruit counting
- Yield prediction
• Crop classification
• Phenology recognition
• Disease detection
• Weed/pest detection
• Fruit counting
• Yield prediction

<table>
<thead>
<tr>
<th>Dataset</th>
<th>Method</th>
<th>Precision</th>
<th>Recall</th>
<th>F1-Score</th>
<th>Accuracy</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cotton</td>
<td>CNN-BA</td>
<td>87.32</td>
<td>86.14</td>
<td>86.58</td>
<td>86.54</td>
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<tr>
<td>Pepper</td>
<td>CNN-BA</td>
<td>88.12</td>
<td>87.24</td>
<td>87.28</td>
<td>87.14</td>
</tr>
<tr>
<td>Corn</td>
<td>CNN-BA</td>
<td>87.32</td>
<td>86.14</td>
<td>86.58</td>
<td>86.54</td>
</tr>
</tbody>
</table>

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- Yield prediction

Mohanty et al. 2016; DOI: 10.3389/fpls.2016.01419

accuracy of 99.35%
• Crop classification
• Phenology recognition
• Disease detection
• Weed/pest detection
• Fruit counting
• Yield prediction
• Crop classification
• Phenology recognition
• Disease detection
• Weed/pest detection
• Fruit counting
• Yield prediction

Chen et al. 2017; DOI: 10.1109/LRA.2017.2651944

Bargoti & Underwood 2016; arXiv:1610.03677v2
What next?

- “...one key shortcoming: no major company has really delivered on the promise of facilitating better in-season decision-making.” (Barclay Rogers, agfundernews, Sep 2018)

- The next big wave in agtech will be better in-season decision-making, including:
  - Directing resource allocation based upon actual field performance
  - Informing in-season fertilizer applications
  - Detecting pest and disease pressure
  - Evaluating product performance
  - Guiding irrigation decisions
  - Forecasting field-level yields
  - Providing better management zones

https://agfundernews.com/whats-next-for-agtech.html/
Future?

- Hyperspectral imaging: greater source of data for analysis
- Drone tech
- Crop models: AI methods
- Databases and decision making?


VTT creates the world’s first hyperspectral iPhone camera

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Impedance?

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Plant
Animal
Land
Mech.

Crop classification
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Weed/pest detection
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MIKÄ-DATA context