



**THE OHIO STATE UNIVERSITY**

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# **The Reality of Artificial Intelligence and Other Disruptive Ag Tech**

**S.A. Shearer**

**Food, Agricultural and Biological Engineering**



# Ag Tech Startups

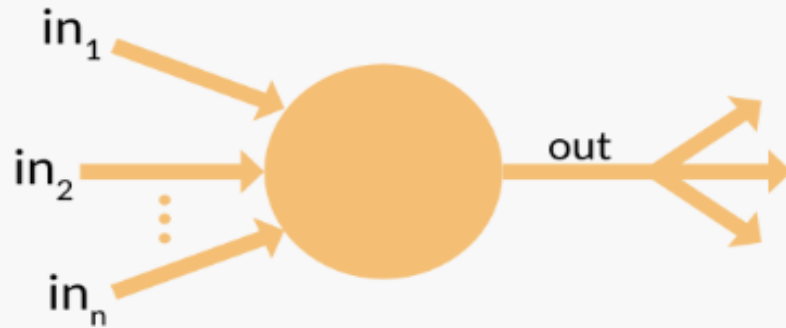
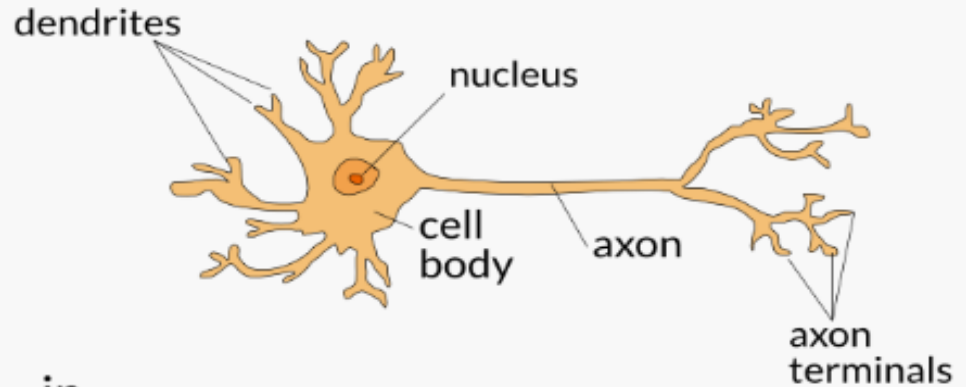






# Neural Networks

- Just nerve cells in the brain, each neural net node has input and output links
- All neural net nodes are connected by these links



(Source: <https://medium.com/coinmonks/the-artificial-neural-networks-handbook-part-1-f9ceb0e376b4>)



# Modeled After Human Brain

- While the human brain has connected nerve cells, neural nets are made up of a series of connected nodes.



(Source: <https://www.xenonstack.com>)

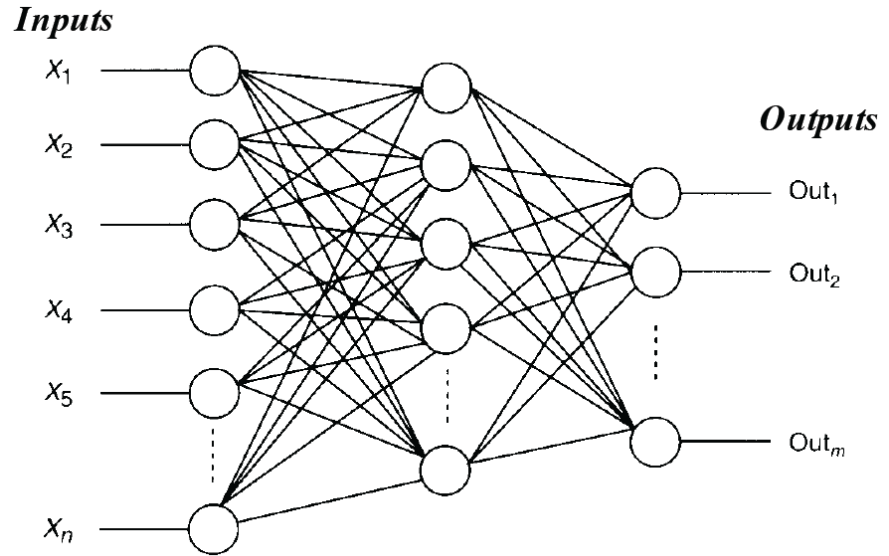


Image courtesy of J. Davis, OSU



# Node Composition

- Each input link has a weight ( $W$ ) associated with it
- Weights are modified to bring the network's output to goal behavior
- Activation functions calculate node output based on weighting and input value
- Node activation based on input values drive classification output

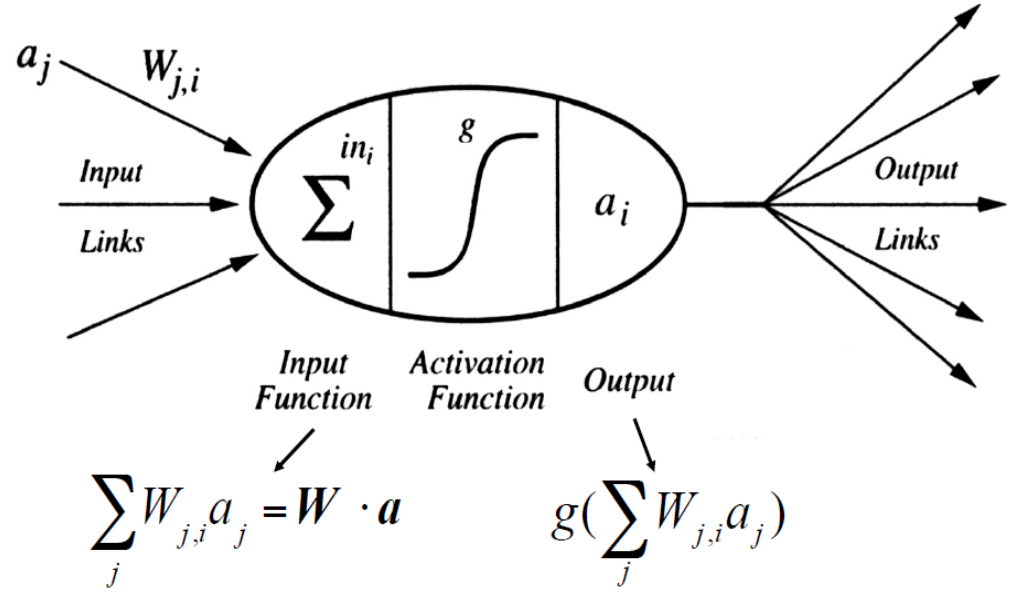


Image courtesy of J. Davis, OSU



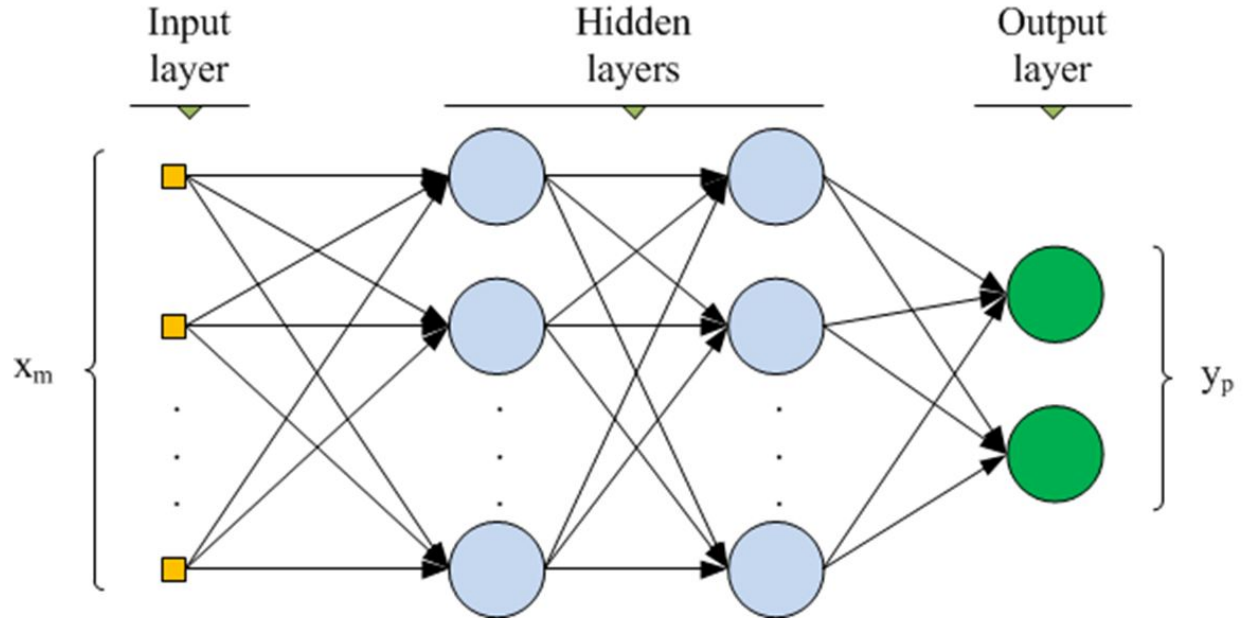
# Multilayer Perceptrons

## Use MLPs for:

- Tabular datasets
- Classification prediction problems
- Regression prediction problems

## Try MLPs on:

- Image data
- Text Data
- Time series data
- Other types of data





# Recurrent Neural Networks

## Use RNNs for:

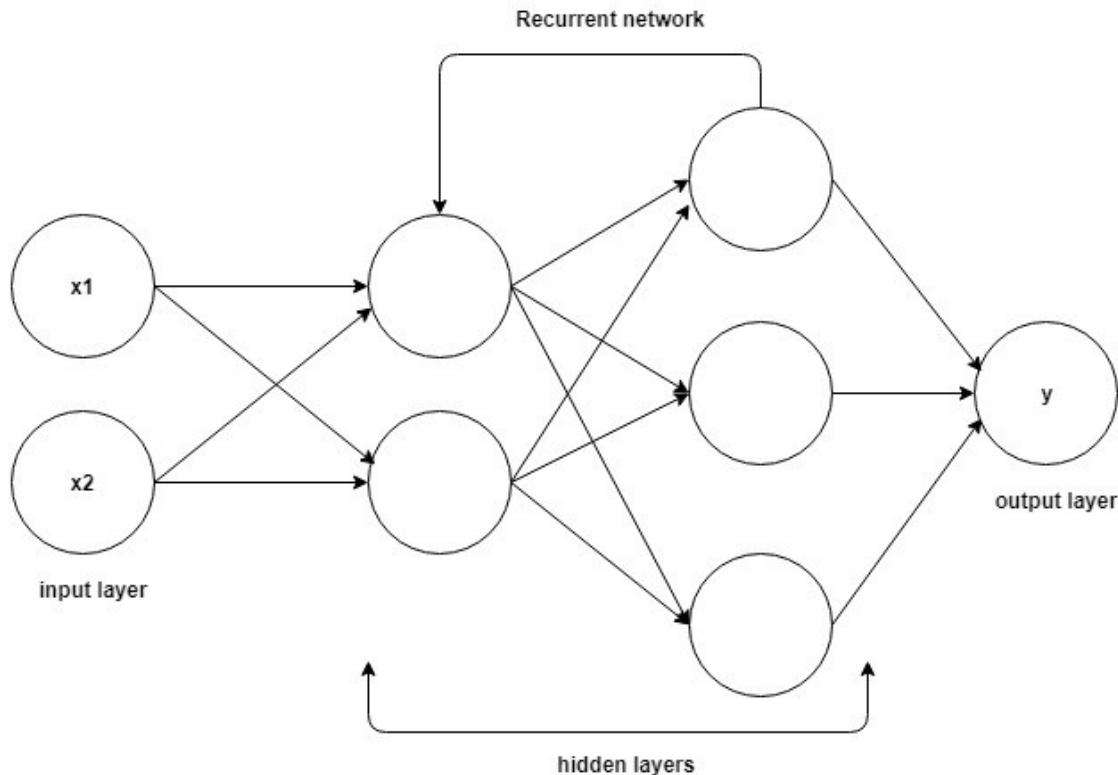
- Text data
- Speech data
- Classification prediction problems
- Regression prediction problems

## Don't use RNNs for:

- Tabular data
- Image data

## Perhaps try RNNs on:

- Time series data





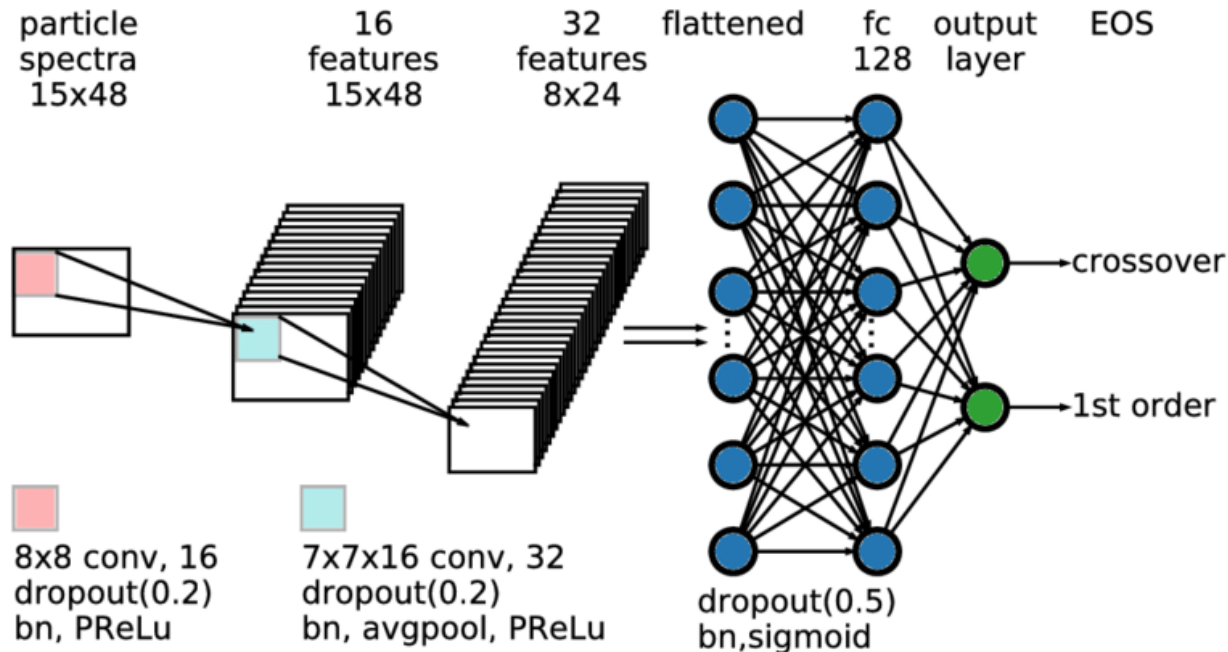
# Convolution Neural Networks

## Use CNNs for:

- Image data prediction problems
- Classification prediction problems
- Regression prediction problems

## Try CNNs on:

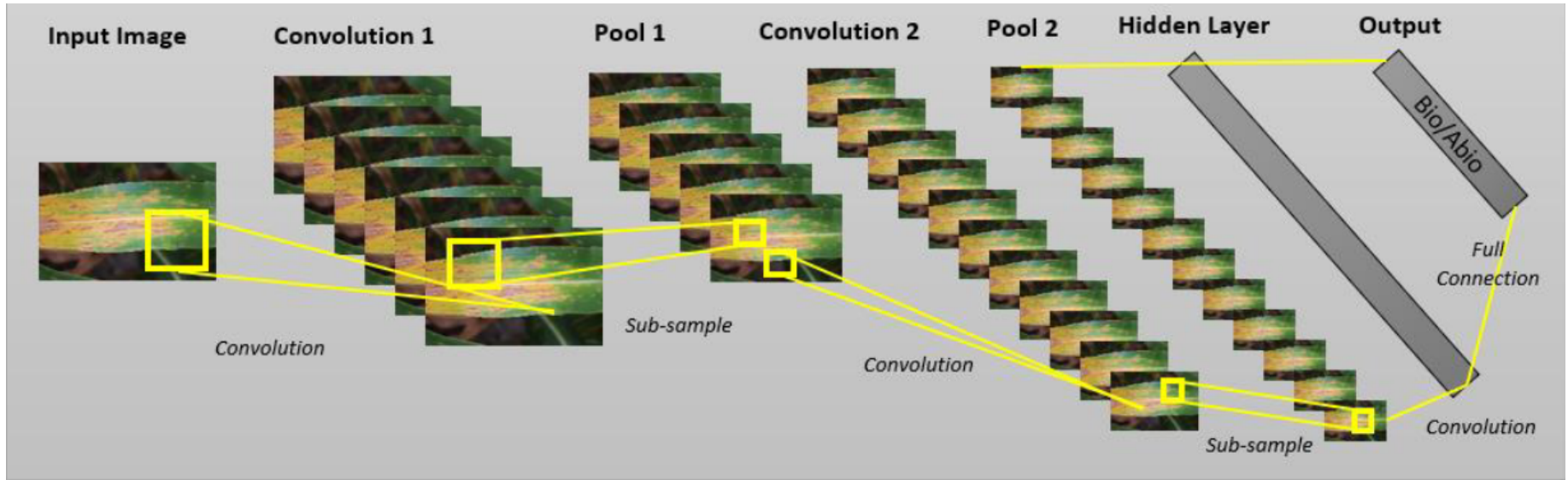
- Text data
- Time series data
- Sequence input data





# CNNs for Crop Stress Diagnosis

- Convolution layers select features (lesions, lesion size, orientation, etc.)
- Fully connected layers calculate classification output (i.e. stress class)





# SSCHS Objectives

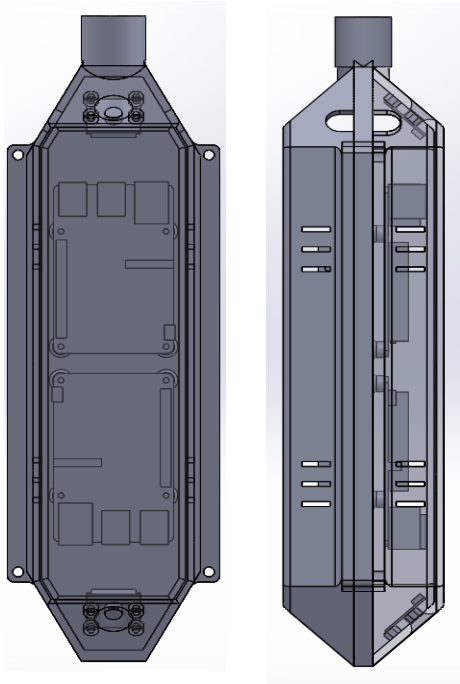
1. Demonstrate intra-canopy sensing with Stinger Suspended Crop Health Sensing System (SSCHS)
2. Develop image reference library for crop health assessment
3. Develop and validate computational and processing algorithms
4. Conduct field scale testing



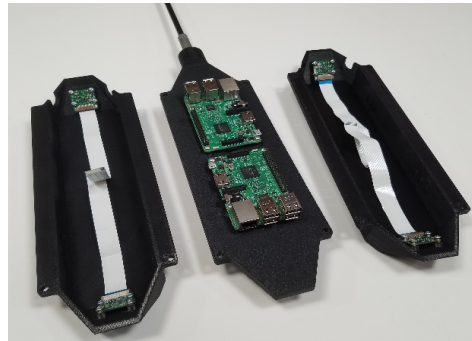




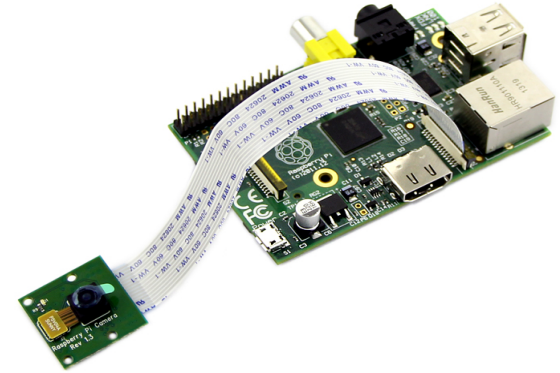
# Imaging Payload



3D Camera Head Design



Fabricated Camera Head



Raspberry Pi Camera Module V2 w/  
Sony IMX219 8-Megapixel Sensor





# PLSDA Field Lab



**NVIDIA TITAN Xp GPUs**

**Dell Precision Tower 7810 w/ 12 core Intel Xeon processors, 64 GB RAM, and 500 GB SSD**





# Reference Library



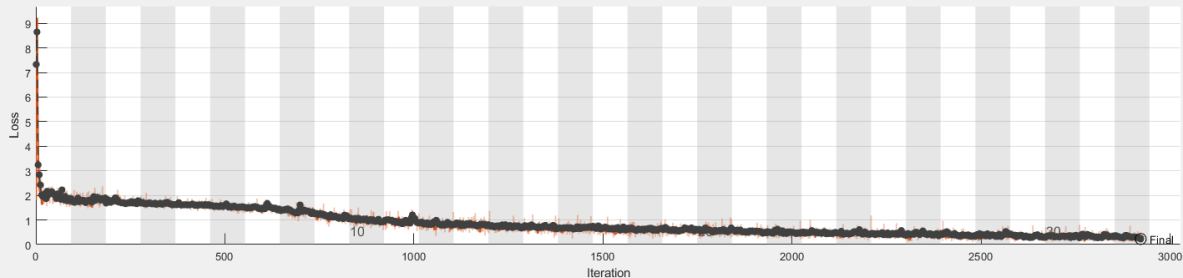
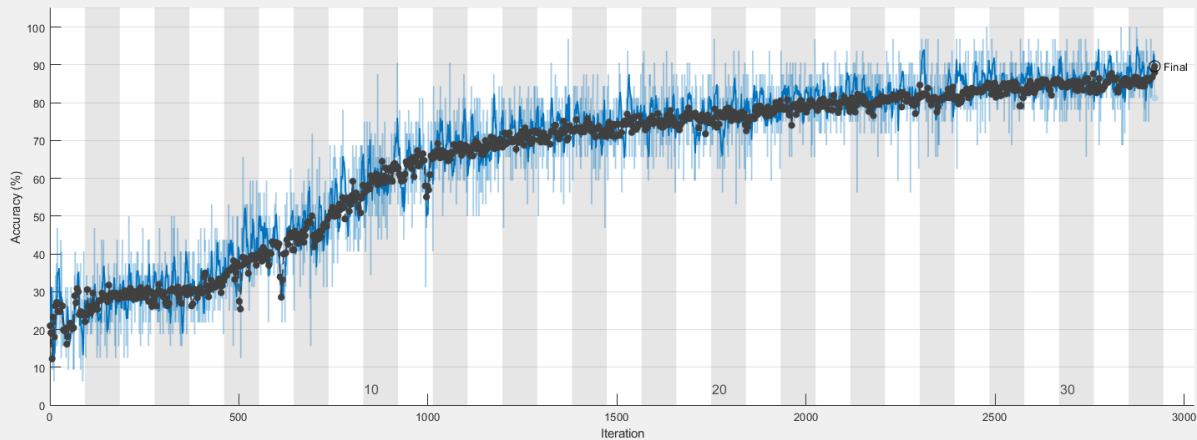
Stress Category	No. of Images
Dicamba Damage	780
Frogeye Leaf Spot	704
Insect Damage	517
Sudden Death Syndrome	748
Healthy	695
Phyllosticta/Bacterial Blight	268
<b>Total</b>	<b>3,712</b>



# CNN Training - Soybean Stress

Training Progress (02-Jan-2019 17:00:09)

Training Progress (02-Jan-2019 17:00:09)



**Results**  
Validation accuracy: 89.64%  
Training finished: Stopped manually

**Training Time**  
Start time: 02-Jan-2019 17:00:09  
Elapsed time: 6626 min 21 sec

**Training Cycle**  
Epoch: 32 of 75  
Iteration: 2922 of 6900  
Iterations per epoch: 92  
Maximum iterations: 6900

**Validation**  
Frequency: 3 iterations  
Patience: Inf

**Other Information**  
Hardware resource: Single GPU  
Learning rate schedule: Constant  
Learning rate: 0.025

[Learn more](#)

**Accuracy**  
— Training (smoothed)  
— Training  
- - Validation

**Loss**  
— Training (smoothed)  
— Training  
- - Validation

4.5 Days Training



# Confusion Matrix

Output Class	BacterialBlight_p_hyloistica	48 6.5%	0 0.0%	45 6.1%	0 0.0%	0 0.0%	0 0.0%	51.6% 48.4%
	DicambaDamage	1 0.1%	154 20.7%	0 0.0%	1 0.1%	4 0.5%	0 0.0%	96.3% 3.7%
	FrogeyeLeafSpot	0 0.0%	0 0.0%	92 12.4%	0 0.0%	2 0.3%	0 0.0%	97.9% 2.1%
	Healthy	0 0.0%	0 0.0%	1 0.1%	133 17.9%	6 0.8%	1 0.1%	94.3% 5.7%
	InsectFeedingDamage	0 0.0%	2 0.3%	3 0.4%	5 0.7%	91 12.2%	0 0.0%	90.1% 9.9%
	SuddenDeathSyndrome	4 0.5%	0 0.0%	2 0.3%	0 0.0%	0 0.0%	148 19.9%	96.1% 3.9%
		90.6% 9.4%	98.7% 1.3%	64.3% 35.7%	95.7% 4.3%	88.3% 11.7%	99.3% 0.7%	89.6% 10.4%
	BacterialBlight_p_hyloistica	DicambaDamage	FrogeyeLeafSpot	Healthy	InsectFeedingDamage	SuddenDeathSyndrome		
		Target Class						





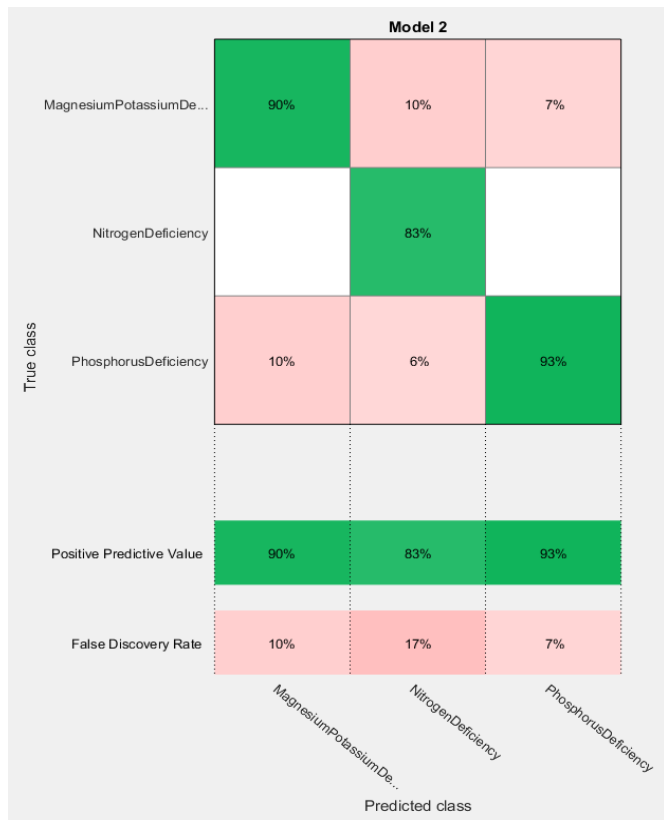
# Corn Stress Reference Library



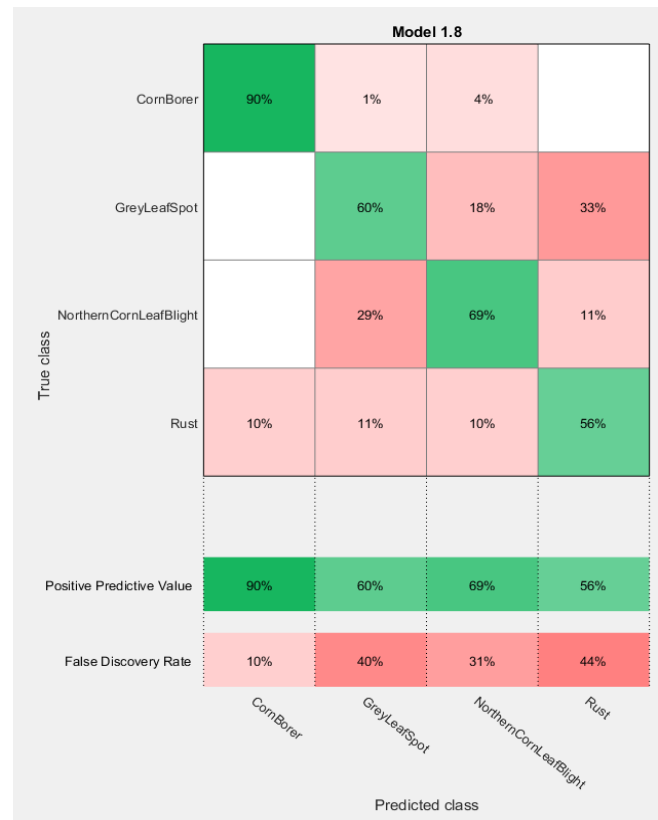


# Support Vector Machine

## Abiotic Stress Discrimination



## Biotic Stress Discrimination





# See and Spray Technology

John Deere/Blue River  
Targeted Application  
(Vision Systems and AI)



(Source: <https://www.theverge.com>)





# In-Field Sensor Networks

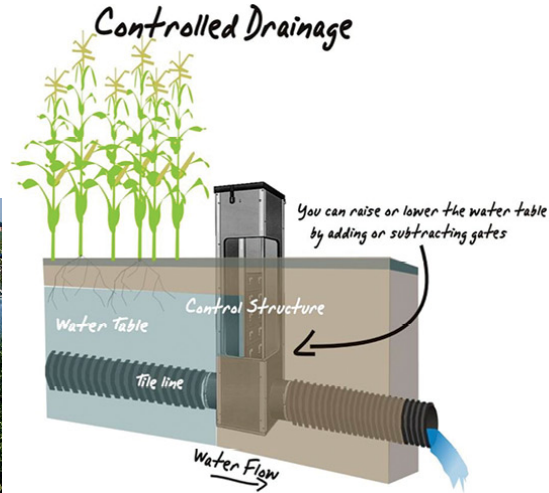




# Controlled Irrigation and Drainage



(Source: [www.valley-au.com](http://www.valley-au.com))



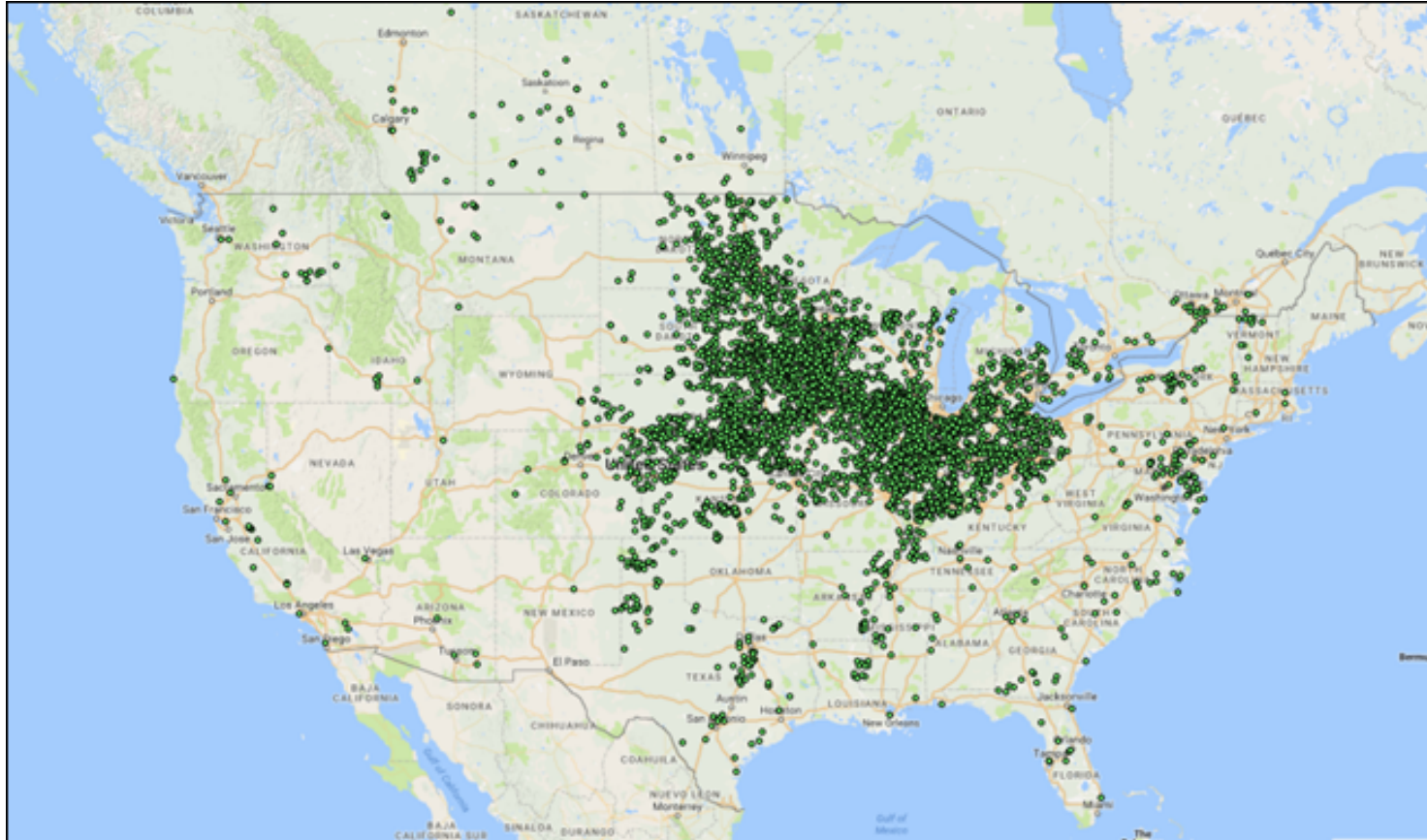
(Source: [www.no-tillfarmer.com](http://www.no-tillfarmer.com))



(Source: [financialtribune.com](http://financialtribune.com))



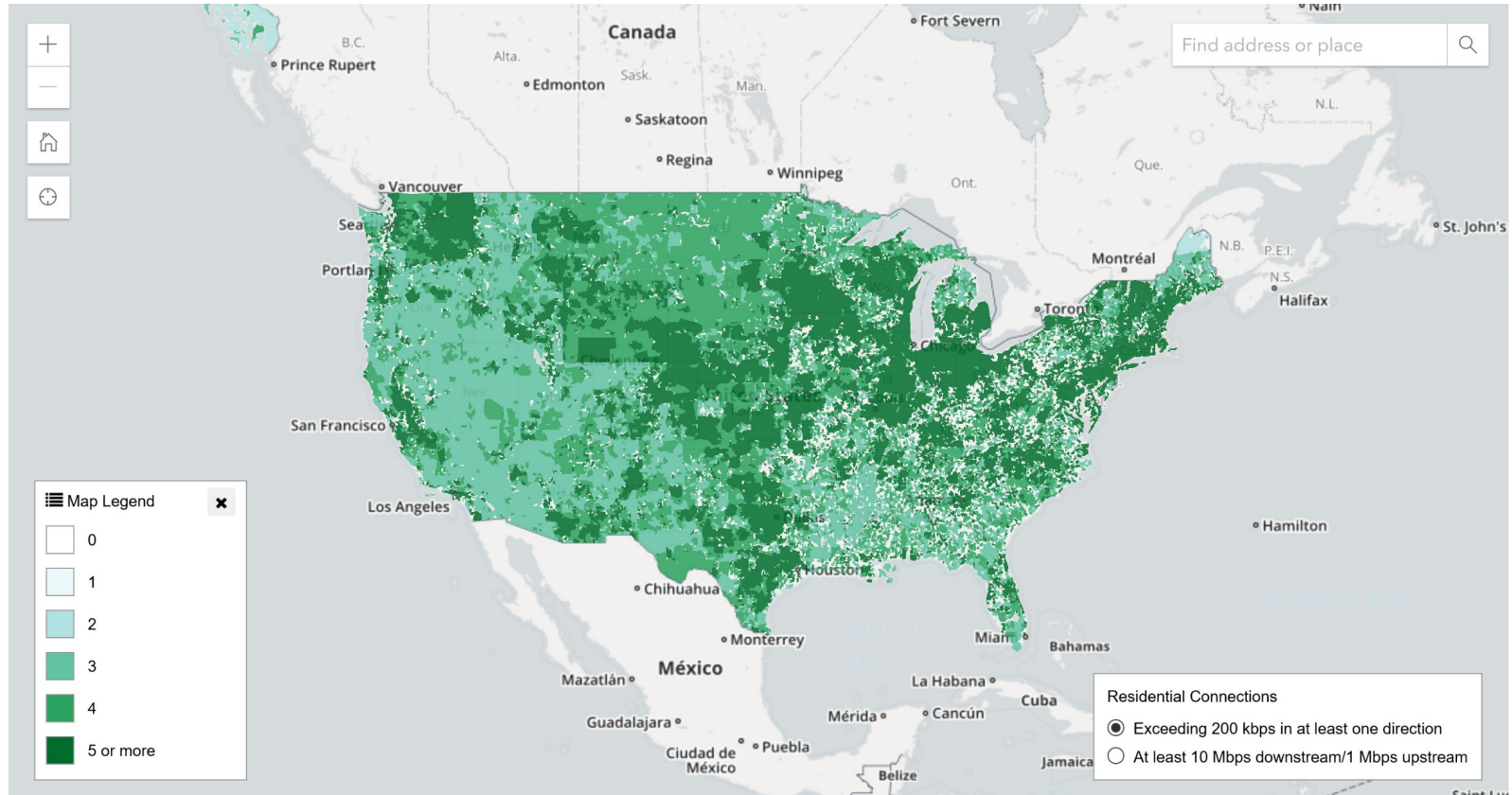
# DTN Weather Station Network







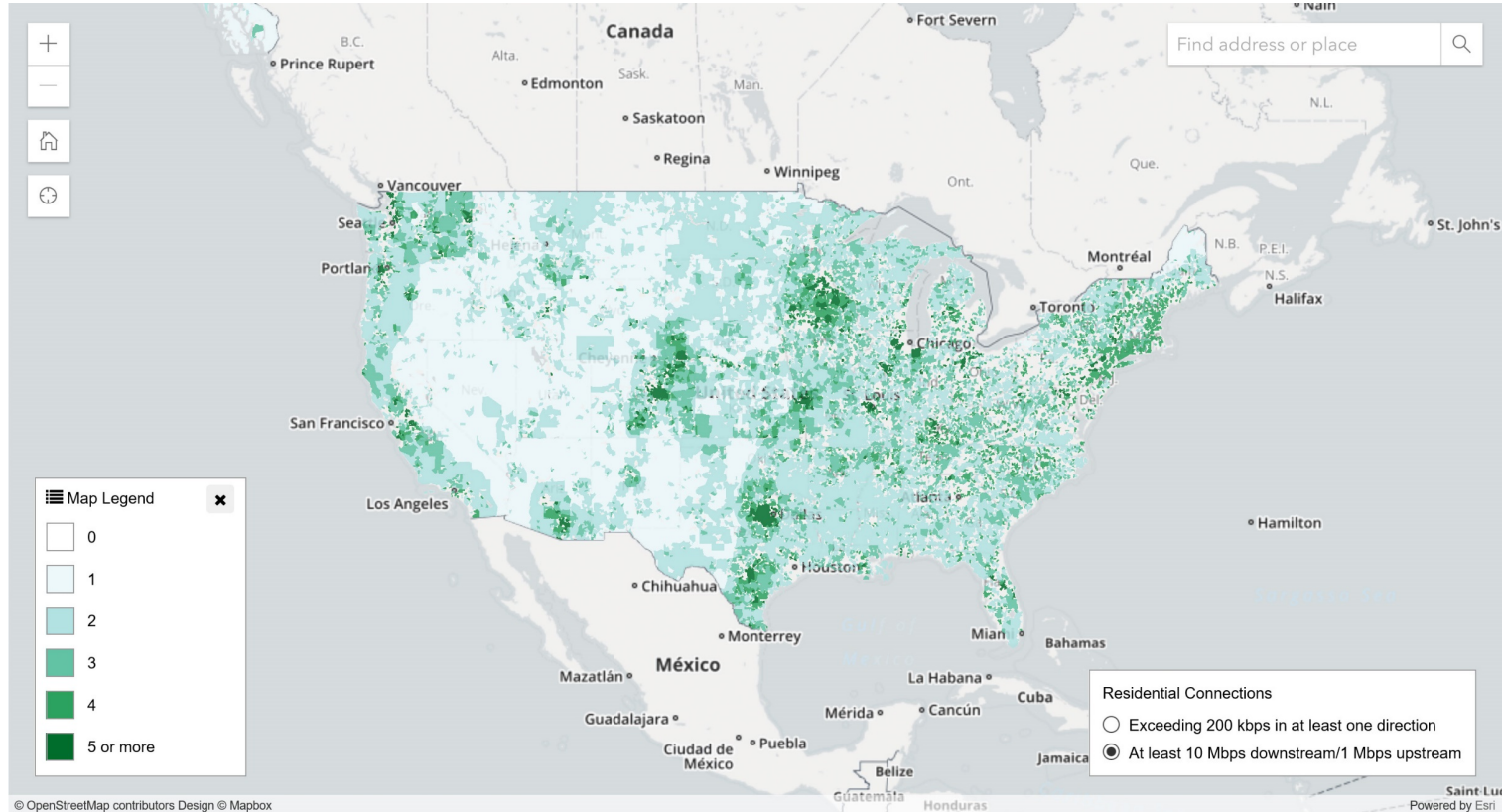
# Internet Access 200 kbps – FCC 2017



Source: [www.fcc.gov](http://www.fcc.gov)



# Internet Access 10 Mbps – FCC 2017



Source: [www.fcc.gov](http://www.fcc.gov)



# AWS Data Center



(Source: [www.avalara.com](http://www.avalara.com))





# Evolving Data Ecosystems

MONSANTO AgBiome 640 Labs  
 THE CLIMATE CORPORATION BLUE RIVER TECHNOLOGY  
 CLIMATE FIELDVIEW<sup>pro</sup> FieldScripts VITAL FIELDS  
 ABSOLVER HydroBio yield pop SOLUM

Trimble CS RainWave AGRI-DATA SOLUTION HarvestMark  
 Irrigation FARM WORKS iron solutions  
 PRECISIONHQ ConnectedFarm

United Suppliers DTN Connect AgSync agX  
 SST Software AGVERITAS<sup>XS</sup> spatial analysis  
 ERDP INTELLIGENCE DN2K ADVISOR

syngenta SST<sup>®</sup> Software Manage Data. Harvest Information.<sup>®</sup>  
 AgConnections AGRIBLE  
 AgriEdgeExcelsior Landodb

Agrium AGRIAN<sup>®</sup> adapt-N echelon  
 JOHN DEERE JOHN DEERE Sage Insights<sup>™</sup> SMART - PRECISE - DECISIVE

LAND O' LAKES, INC. R7 Tool GEOSYS. TAVANT TECHNOLOGIES  
 THE CLIMATE CORPORATION mavrx Agworld esri

PIONEER dtn JOHN DEERE encirca<sup>™</sup> esri

SST<sup>®</sup> Software Manage Data. Harvest Information.<sup>®</sup> scout<sup>pro</sup> adapt-N THE CLIMATE CORPORATION Precision PLANTING  
 Ag Eagle KINZE RAVEN GEOVANTAGE  
 DroneDeploy agX Sirrus

EFC • SYSTEMS<sup>™</sup> Ag Junction Merchant Ag<sup>™</sup> FieldAlytics<sup>™</sup>

BAYER Zoner.ag proPlant JOHN DEERE

JOHN DEERE JOHN DEERE DN2K Precision PLANTING  
 Sage Insights<sup>™</sup> MyJohnDeere

(Source: Prassack Advisors)



# Ag robot proliferation...







# Future of Field Production





# Precision Livestock Systems



(Source: [www.gea.com](http://www.gea.com))



(Source: [www.progressivedairy.com](http://www.progressivedairy.com))



# Precision Livestock Systems







# Controlled Environment Agriculture





# Cryptocurrency and Blockchain

## WALLETS & MONEY SERVICES



## EXCHANGES & CRYPTOCURRENCY TRADING



## P2P MARKETPLACES & P2P LENDING



## MERCHANT SERVICES



## ENTERPRISE SERVICES & CURRENCIES



## SOCIAL & BROWSERS



## CRYPTOCURRENCY MINING



## IoT, IDENTITY & CONTENT MANAGEMENT



## STORAGE, SECURITY & REGULATORY



## CAPITAL MARKETS & FINANCIAL SERVICES



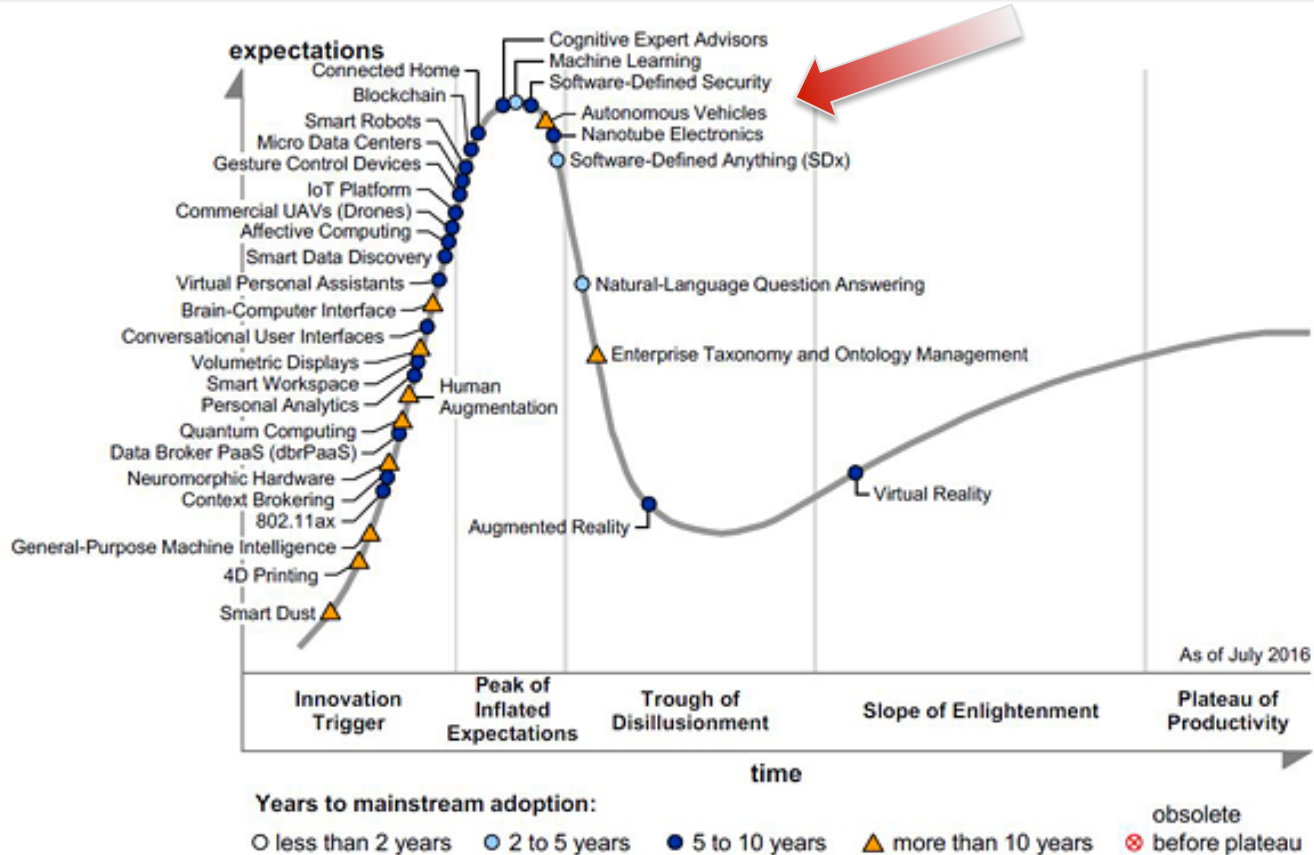


## General Data Protection Regulation

- Individual Rights – Access, Rectification, Erasure, Portability, Restriction
- Record of Processing Activities – Data Mapping and DPIA
- Security of Processing
- Breach Notification



# Gartner Hype Curve





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**Questions?**