IoT for Precision Farming

BADS7205 DATA STREAMING AND REAL TIME ANALYTICS

Overview

- Problem to be solved
- How IoT can improve business performance?
- Components
- System Overview
- Diagram
- Study and Research
- Real Diagram
- Processing Data
- Modeling
- Visualization
- Live demo
- Next Step

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SMART
AGRICULTURE

Problem

Lack
of labor

Low
productivity

Bad
quality

Inaccurate
estimation

How Iot can improve business performance?

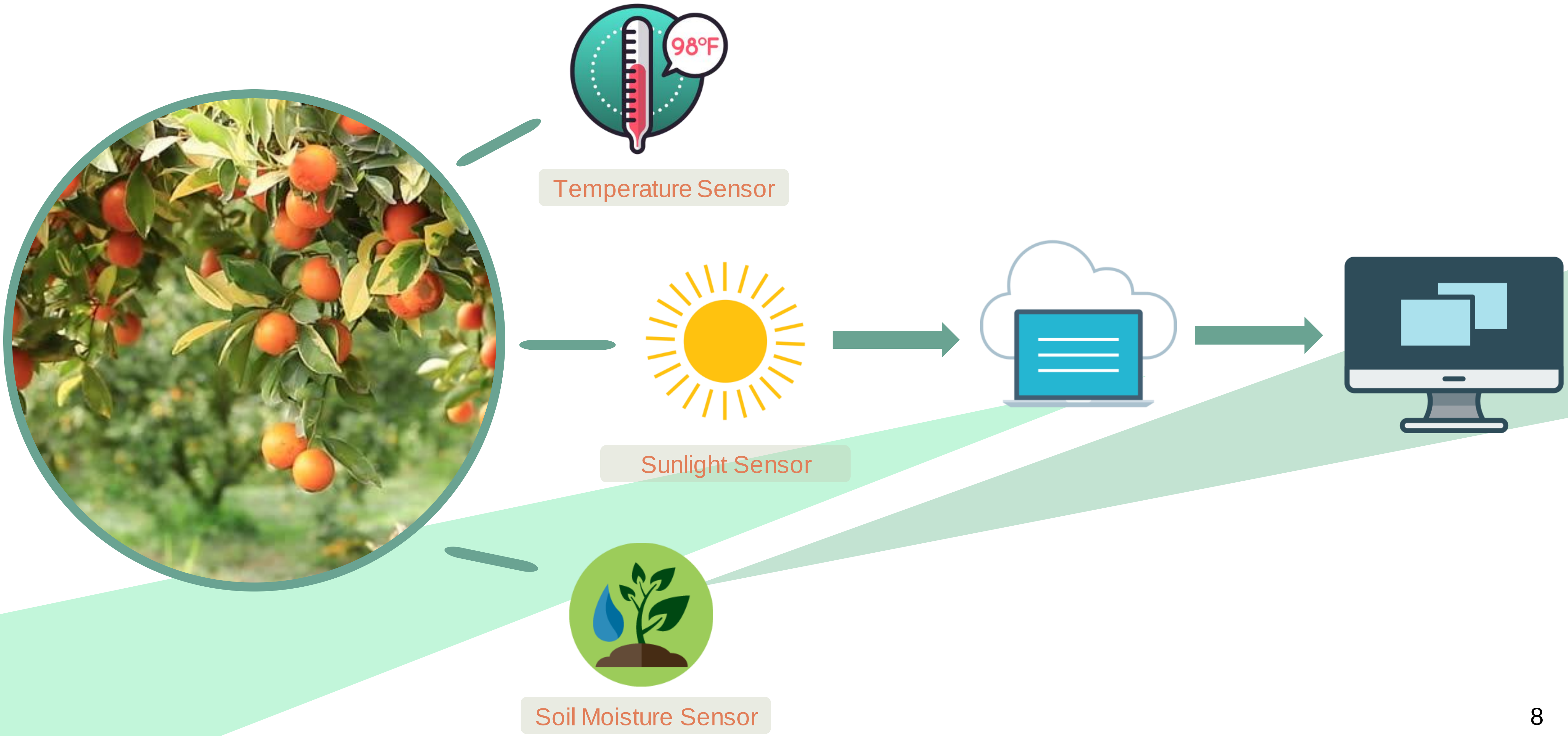
Reduce
labor cost

Increase
productivity

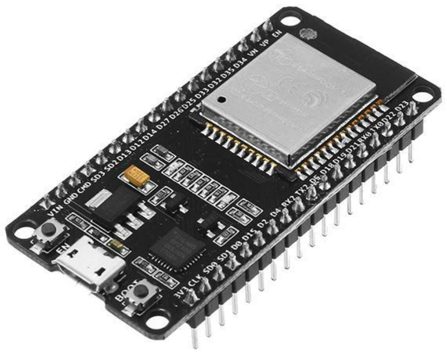
Improve
quality

Precision
estimation

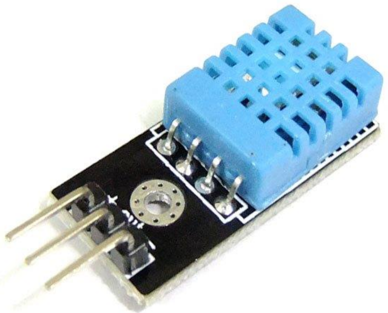
System Overview



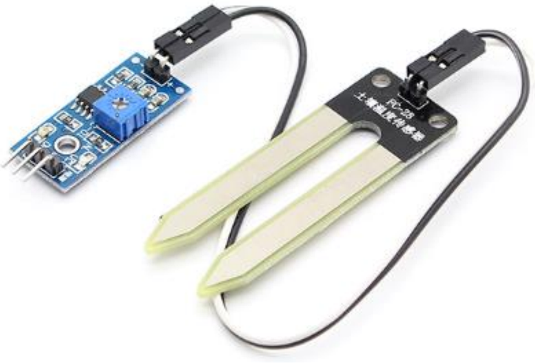
Components



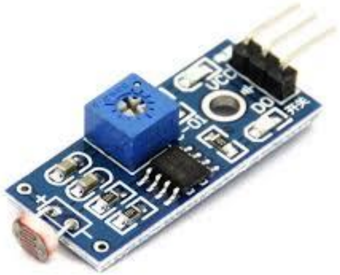
ESP32



DHT11
Temperature Sensor

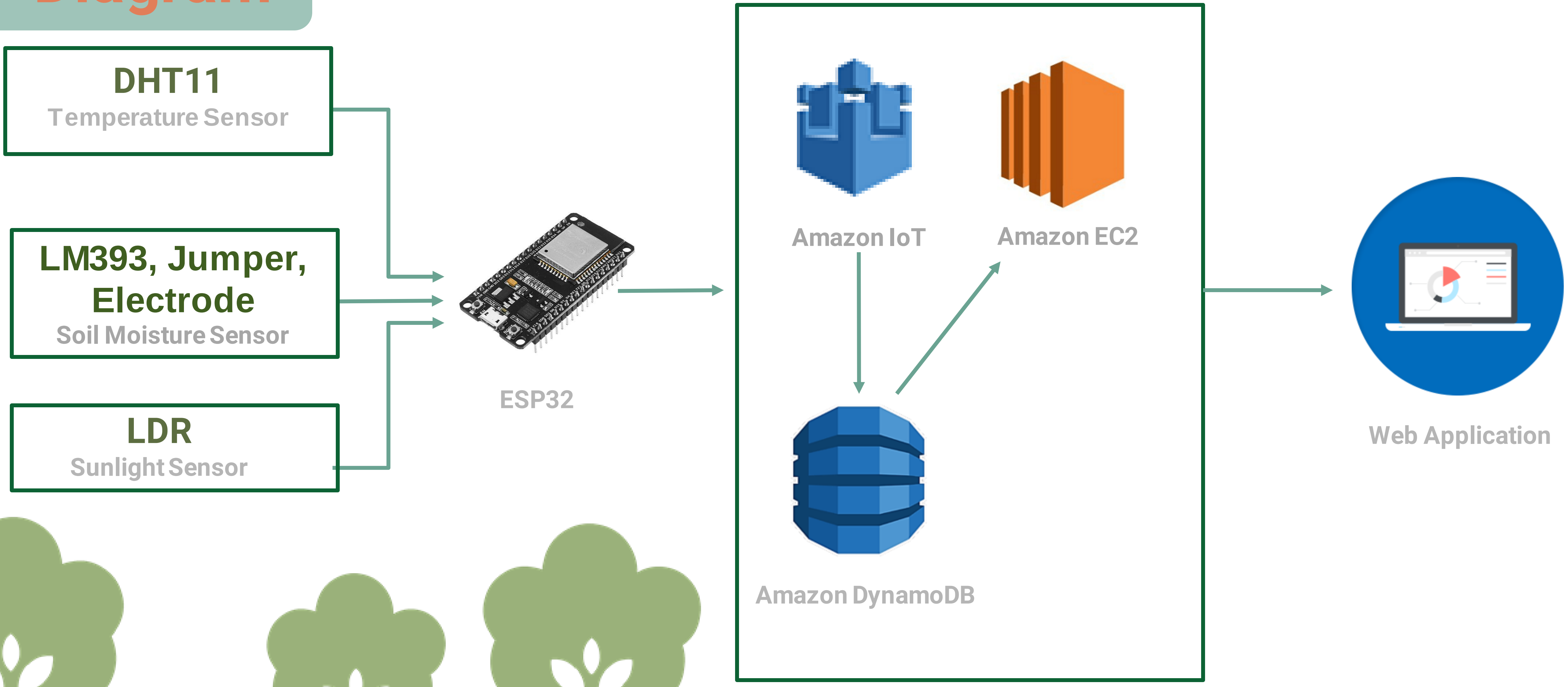


LM393, Jumper, Electrode
Soil Moisture Sensor



LDR
Sunlight Sensor

Diagram


DHT11
Temperature Sensor
LM393, Jumper, Electrode
Soil Moisture Sensor
LDR
Sunlight Sensor
ESP32
Amazon IoT
Amazon EC2
Amazon DynamoDB
Web Application

Study & Research

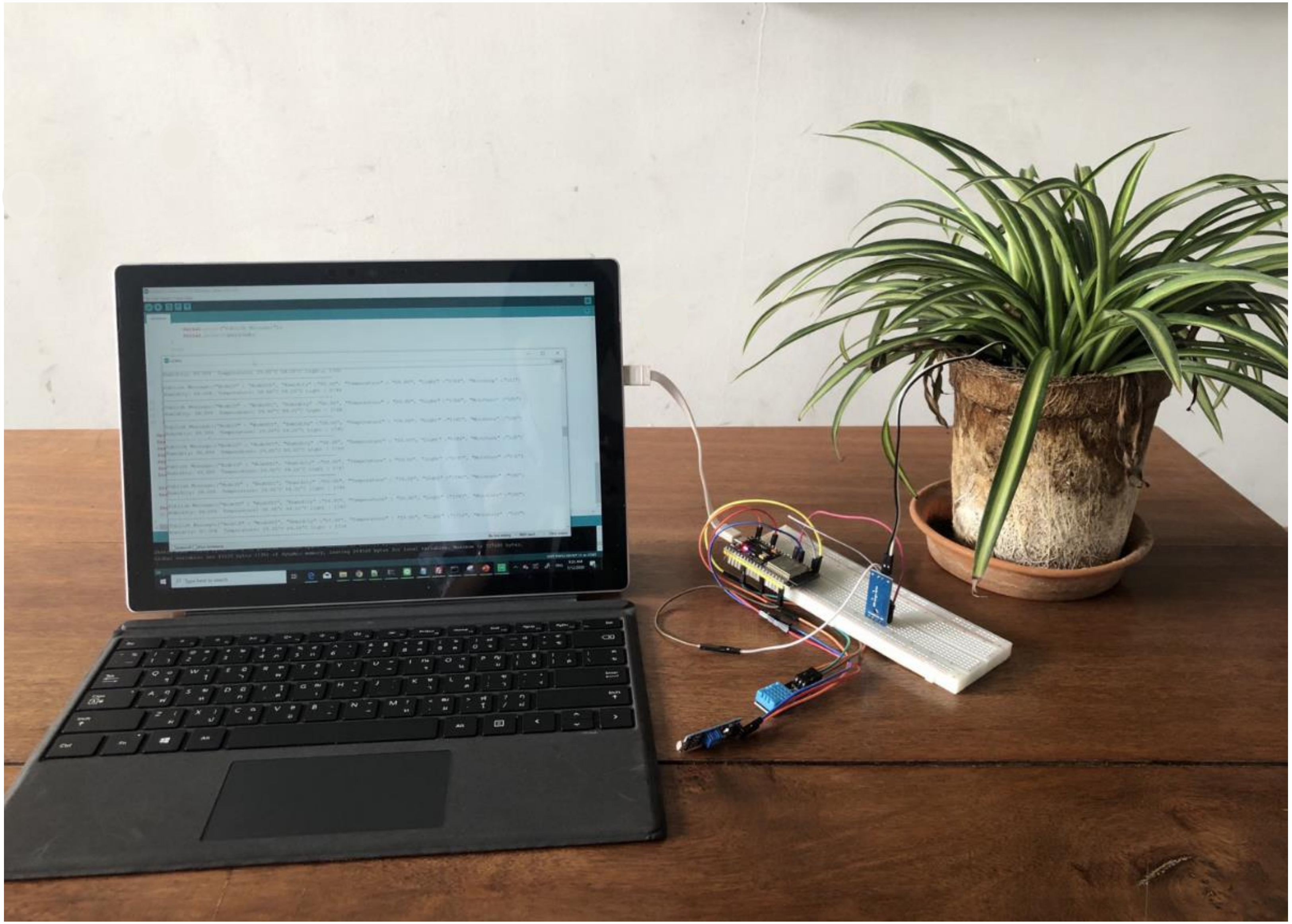
Study

- Crop Performance / Crop Yield – Predictive Analytics
- Combining IoT and Predictive Analytics in Agriculture
- Internet-of-Things (IoT)-Based Smart Agriculture
- Precision Agriculture
- IoT and agriculture data analysis for smart farm

Research

- International Journal of Innovative Research in Science, Engineering and Technology, Regional Digital Ag Lead
- Crop yield predictions - high resolution statistical model for intra-season forecasts applied to corn in the US, Gro Intelligence, Inc.
- Agriculture Yield Prediction Using Predictive Analytic Techniques ,IEEE
- An approach to forecast grain crop yield using multi-layered, multi-farm data sets and machine learning

Real Diagram

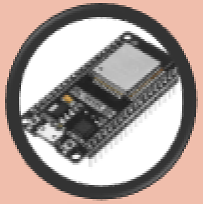


Processing Data - Workflow

Data Collection

Collected Data from Sensor to DynomoDB

- Temperature Sensor
- Soil moisture Sensor
- Sunlight Sensor



Data Preprocessing

1. Using python for import data from arduino to jupyter notebook
2. Data Cleaning and preparation

Data Modeling

Using Linear Regression for Yields Prediction

Data Visualization

Create dashboard and display on Web Application

Processing Data - I

Publish message that gathering from sensors (Temperature, Soil Moisture, Sunlight) in Arduino

COM3

Send

```
Humidity: 53.00%  Temperature: 27.80°C 82.04°C Light : 1168
--------------------------------------------------------
Publish Message:{"NodeID" : "Node001", "Humidity" :"52.00", "Temperature" : "27.80", "Light" :"1168", "Moisture" :"1071"}
Humidity: 52.00%  Temperature: 27.80°C 82.04°C Light : 1168
--------------------------------------------------------
Publish Message:{"NodeID" : "Node001", "Humidity" :"52.00", "Temperature" : "27.80", "Light" :"1167", "Moisture" :"1070"}
Humidity: 52.00%  Temperature: 27.80°C 82.04°C Light : 1167
--------------------------------------------------------
Publish Message:{"NodeID" : "Node001", "Humidity" :"52.00", "Temperature" : "27.80", "Light" :"1168", "Moisture" :"1068"}
Humidity: 52.00%  Temperature: 27.80°C 82.04°C Light : 1168
--------------------------------------------------------
Publish Message:{"NodeID" : "Node001", "Humidity" :"52.00", "Temperature" : "27.80", "Light" :"1168", "Moisture" :"1070"}
Humidity: 52.00%  Temperature: 27.80°C 82.04°C Light : 1168
--------------------------------------------------------
Publish Message:{"NodeID" : "Node001", "Humidity" :"52.00", "Temperature" : "27.80", "Light" :"1168", "Moisture" :"1071"}
Humidity: 52.00%  Temperature: 27.80°C 82.04°C Light : 1168
--------------------------------------------------------
Publish Message:{"NodeID" : "Node001", "Humidity" :"52.00", "Temperature" : "27.80", "Light" :"1168", "Moisture" :"1069"}
Humidity: 52.00%  Temperature: 27.80°C 82.04°C Light : 1168
--------------------------------------------------------
```

Autoscroll Show timestamp No line ending 9600 baud Clear output

Processing Data - II

Ingesting data from sensors to DynamoDB in AWS

Scan: [Table] NodeTable2: NodeID, TimeStamp

Viewing 1 to 100 items

Scan | [Table] NodeTable2: NodeID, TimeStamp

Add filter

Start search

NodeID	TimeStamp	payload
Node001	1578409898657	{ "Humidity" : { "S" : "54.00" }, "Light" : { "S" : "1326" }, "Moisture" : { "S" : "1054" }, "NodeID" : { "S" : "Node001" }, "Temperature" : { "S" : "27.20" }}
Node001	1578409910715	{ "Humidity" : { "S" : "54.00" }, "Light" : { "S" : "1310" }, "Moisture" : { "S" : "1058" }, "NodeID" : { "S" : "Node001" }, "Temperature" : { "S" : "27.20" }}
Node001	1578409922769	{ "Humidity" : { "S" : "54.00" }, "Light" : { "S" : "1383" }, "Moisture" : { "S" : "1058" }, "NodeID" : { "S" : "Node001" }, "Temperature" : { "S" : "27.20" }}
Node001	1578409934733	{ "Humidity" : { "S" : "54.00" }, "Light" : { "S" : "1324" }, "Moisture" : { "S" : "1053" }, "NodeID" : { "S" : "Node001" }, "Temperature" : { "S" : "27.20" }}
Node001	1578409946787	{ "Humidity" : { "S" : "54.00" }, "Light" : { "S" : "1328" }, "Moisture" : { "S" : "1051" }, "NodeID" : { "S" : "Node001" }, "Temperature" : { "S" : "27.10" }}
Node001	1578409958975	{ "Humidity" : { "S" : "54.00" }, "Light" : { "S" : "1302" }, "Moisture" : { "S" : "1057" }, "NodeID" : { "S" : "Node001" }, "Temperature" : { "S" : "27.20" }}
Node001	1578409971210	{ "Humidity" : { "S" : "54.00" }, "Light" : { "S" : "1351" }, "Moisture" : { "S" : "1041" }, "NodeID" : { "S" : "Node001" }, "Temperature" : { "S" : "27.20" }}
Node001	1578409983253	{ "Humidity" : { "S" : "55.00" }, "Light" : { "S" : "1365" }, "Moisture" : { "S" : "1053" }, "NodeID" : { "S" : "Node001" }, "Temperature" : { "S" : "27.10" }}
Node001	1578409995171	{ "Humidity" : { "S" : "54.00" }, "Light" : { "S" : "1342" }, "Moisture" : { "S" : "1056" }, "NodeID" : { "S" : "Node001" }, "Temperature" : { "S" : "27.10" }}
Node001	1578410007135	{ "Humidity" : { "S" : "54.00" }, "Light" : { "S" : "1325" }, "Moisture" : { "S" : "1053" }, "NodeID" : { "S" : "Node001" }, "Temperature" : { "S" : "27.10" }}

Processing Data - III

Import data from DynamoDB and processing in python script.

In [95]:
```python
import boto3
from boto3.dynamodb.conditions import Key, Attr
import pandas as pd
import time, os
from datetime import datetime, timedelta, date

dynamodb = boto3.resource('dynamodb')
table = dynamodb.Table('NodeTable2')
```

In [96]:
```python
response = table.scan(
    ProjectionExpression='payload, #c',
    ExpressionAttributeNames = {'#c': 'TimeStamp'})
```

Processing Data - IV

Data Preparation: Null impution, Shifting data

	timestamp	Sunlight Sensor	Humidity Sensor	Tempurature Sensor	Soil Moisture Sensor
0	1/07/2020 22:11	1326	54.00	27.20	1054
1	1/07/2020 22:11	1310	54.00	27.20	1058
2	1/07/2020 22:12	1383	54.00	27.20	1058
3	1/07/2020 22:12	1324	54.00	27.20	1053
4	1/07/2020 22:12	1328	54.00	27.10	1051

Processing Data - V

Data Modeling: Linear Regression
X variable: Temperature, Soil Moisture, Sunlight
Y variable: Yield

```
In [17]: lm = LinearRegression()

In [18]: lm.fit(X_train, y_train)

Out[18]: LinearRegression(copy_X=True, fit_intercept=True, n_jobs=None,
                  normalize=False)

In [19]: lm.intercept_

Out[19]: 14.334381090531927
```

Modeling

From previously research,

$$Prod\_Lemon = 0.89 * Temp + 0.07 * DHT - 0.02 * Humidity - 25.87, \quad (2)$$

$$Prod\_Veg = 0.16 * Temp + 0.10 * DHT - 0.04 * Humidity - 7.29. \quad (3)$$

Approach

1. Time series data have to shift with input by average and shift yield one month later.
2. Using shifted data to create linear regression model.

Refer to this data mining research ,https://sci-hub.tw/10.1016/j.compag.2018.12.011.
The results showed that suitable temperature for high productivity of homegrown vegetables and lemons was between 29 °C and 32 °C. Moreover, suitable humidity for high productivity of lemons was within 72–81%

Visualization

http://ec2-54-255-204-152.ap-southeast-1.compute.amazonaws.com/IoT/IoT/index_dashboard.php

Live Demo

Next Step

Sensor

Adding paramenter
(new sensors)
Eg.
- Soil pH Sensor
- Mineral Moisture Sensor
- Rain Detection Sensor

Analytics

Tuning model and
trying other
model that
might more powerful
than Linear Regression
Eg.
-LSTM
-Catboost

Optimization

- Cost
- Proportion of plant
-Labor hour

Visualization

Asking user requriement to
create/design other
dashboard that impactful to
them

Automate

Automating task
Eg.
- Sending message or
notification to
Mobile application when meet
the specific condition
- Watering the plant

THANK YOU