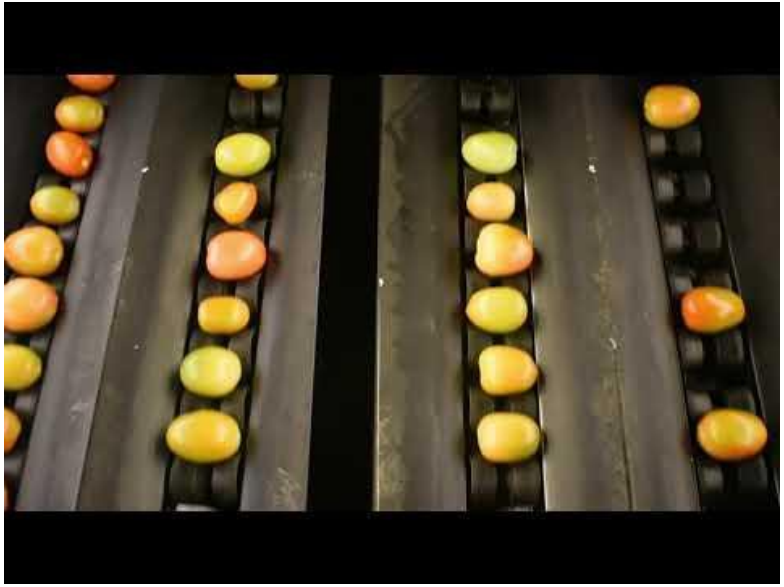
Visión Computacional y Machine Learning en la Industria Post-cosecha

Saul Cuen

DataDay 2023
EGADE, Tec de Mty
Nov-14

Sistema de Visión para la industria postcosecha



AGRICULTURA
SECRETARÍA DE AGRICULTURA Y DESARROLLO RURAL

SIAP
SERVICIO DE INFORMACIÓN AGROALIMENTARIA Y PESQUERA

Escenario mensual de productos agroalimentarios

Dirección de Análisis Estratégico

13 de junio de 2022

Tomate rojo (Jitomate)

Producción 2022		Comercio exterior 2021		Semáforo
Estimada	Otoño-Invierno Abril 2022	Importaciones	Exportaciones	
1,562,558 toneladas	**862,557** toneladas	**NS** toneladas	**1,730,149** toneladas	

Evolución mensual de las importaciones y exportaciones mexicanas de jitomate 2019-2022

(miles de toneladas)

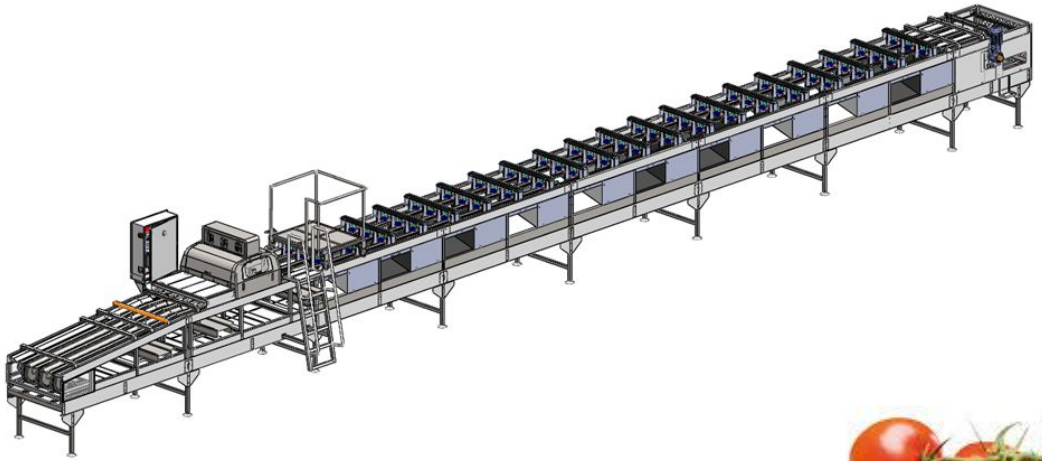
Nota: Los volúmenes comerciales no consideran los retornos.
Fuente: SIAP con datos aduaneros de México.

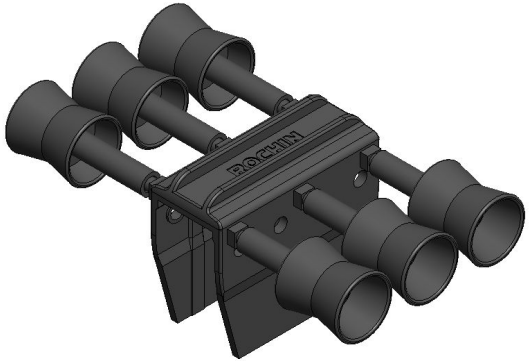
Principales países exportadores de tomate en 2020

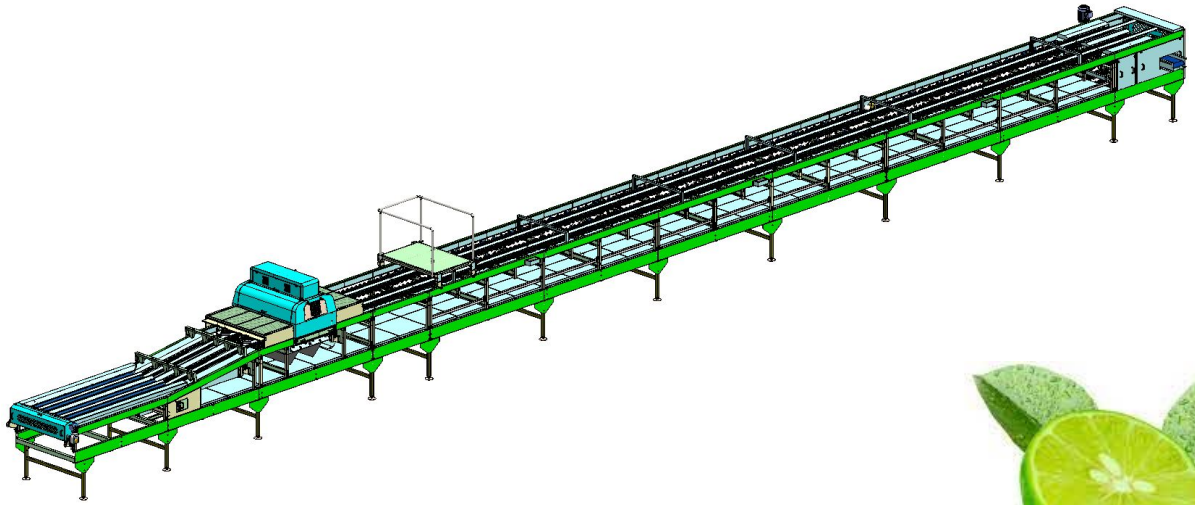
País	Volumen (t)	Volumen (%)	Valor (mdd)	Valor (%)
México	1,826,715	23.5	2,606	26.4
Países Bajos	1,024,069	13.2	1,919	19.4
España	734,223	9.4	1,074	10.9
Marruecos	596,719	7.7	770	7.8
Turquía	513,835	6.6	310	3.1

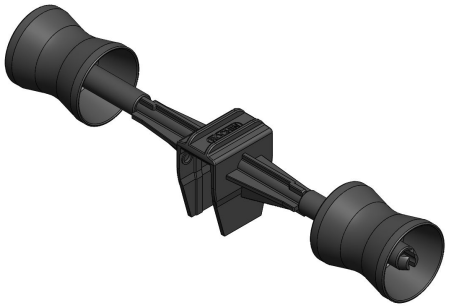
Fuente: FAO-FAOSTAT/ProducePay 2020

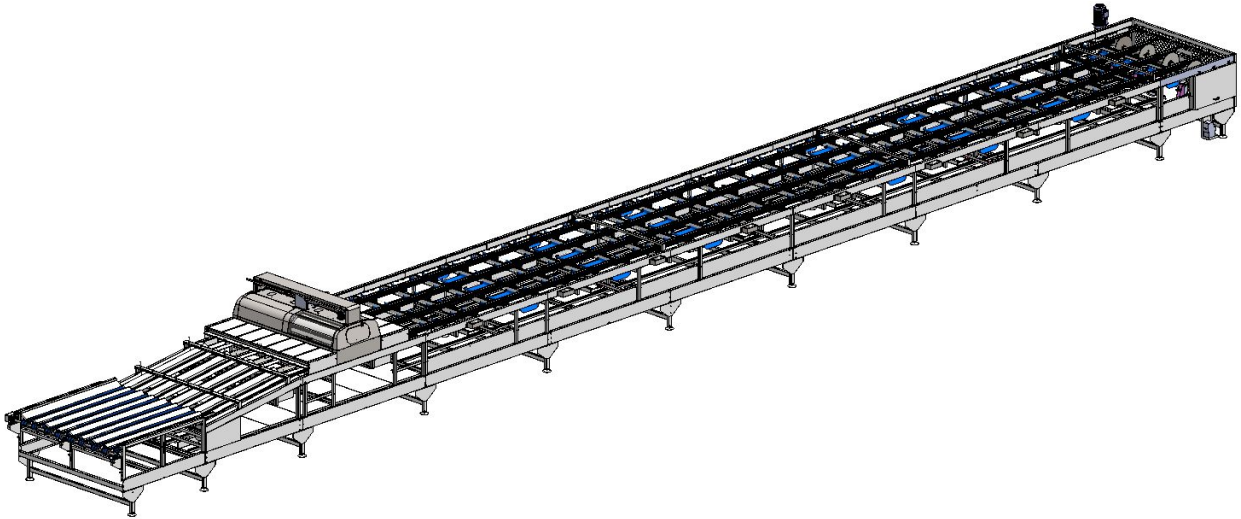
Food and Agriculture Organization (FAO)

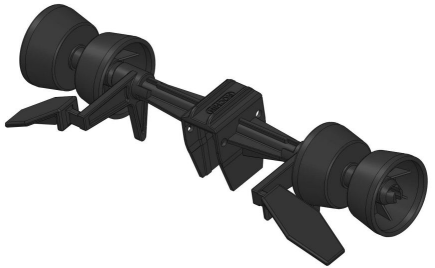


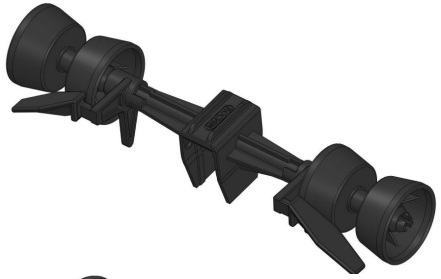


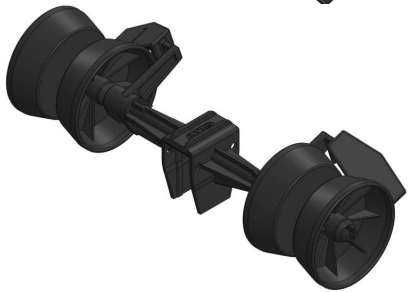


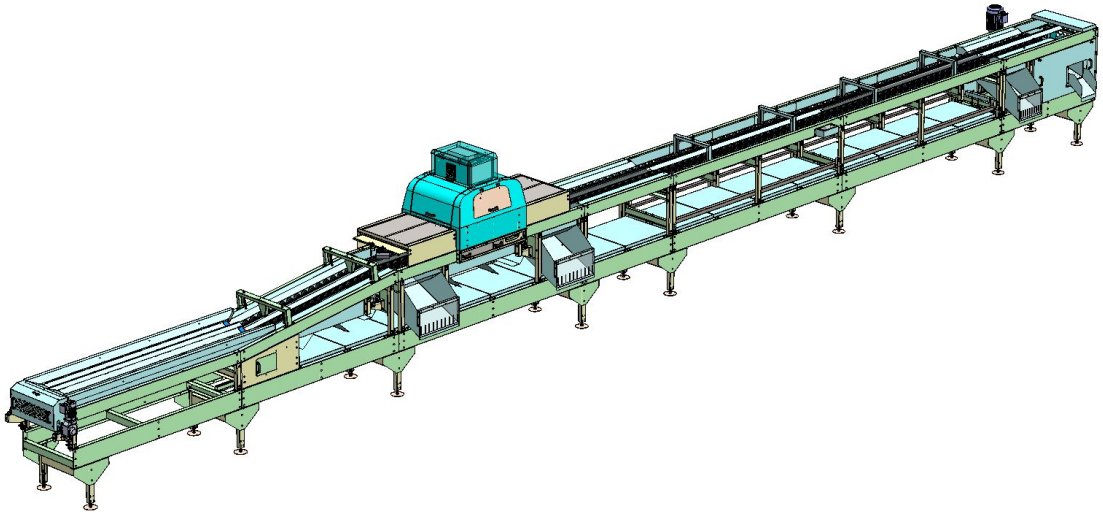


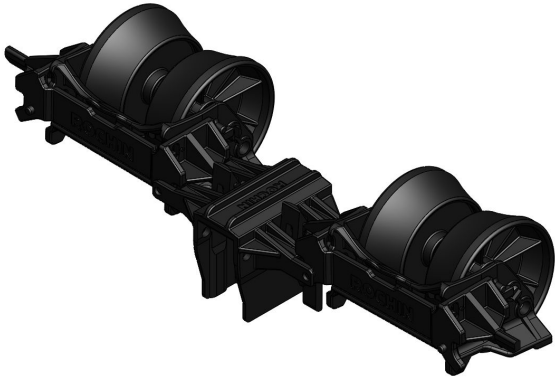


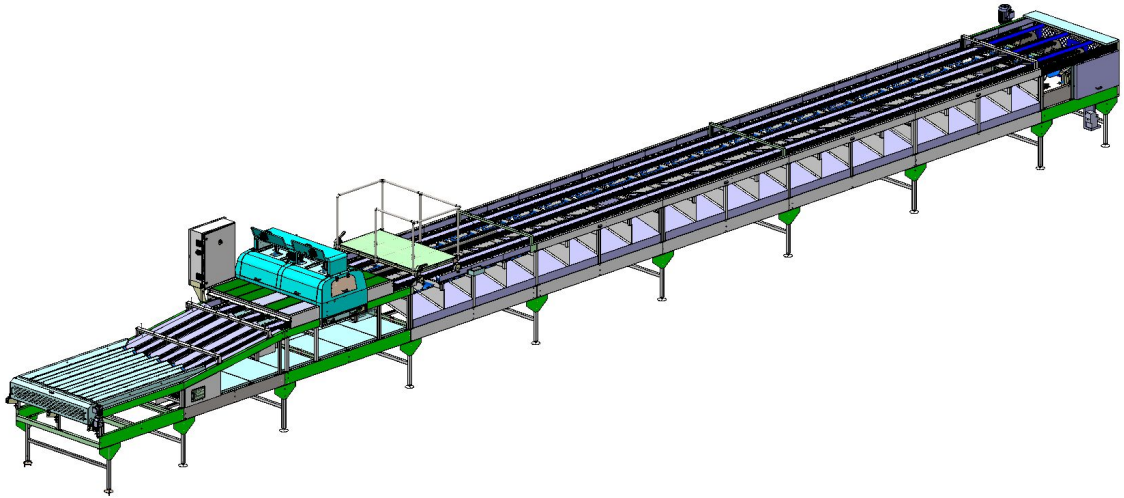


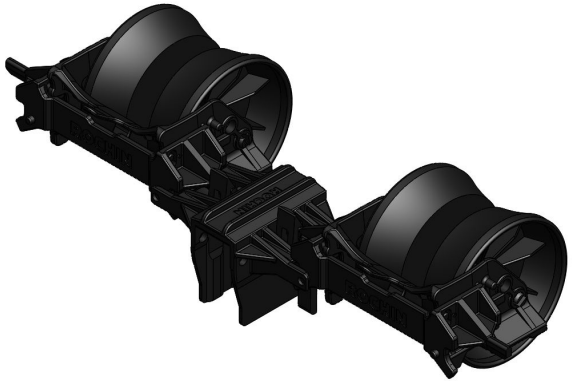


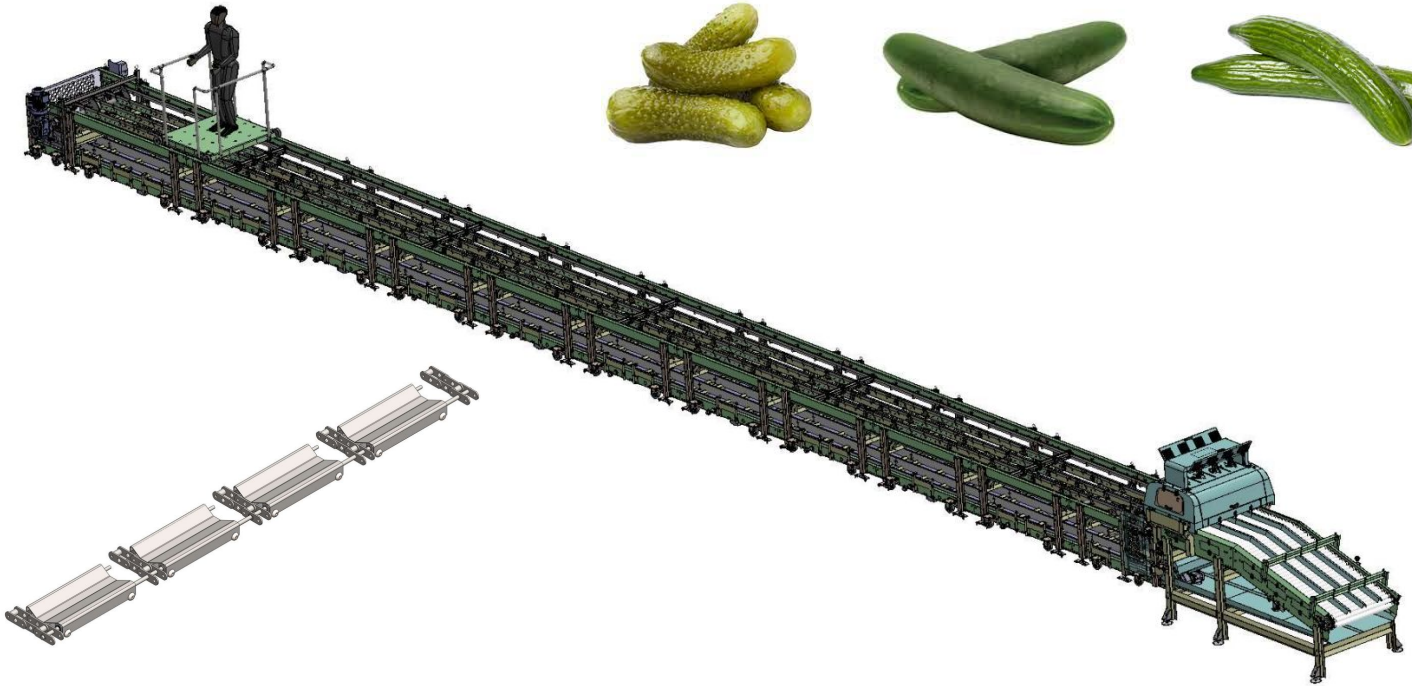




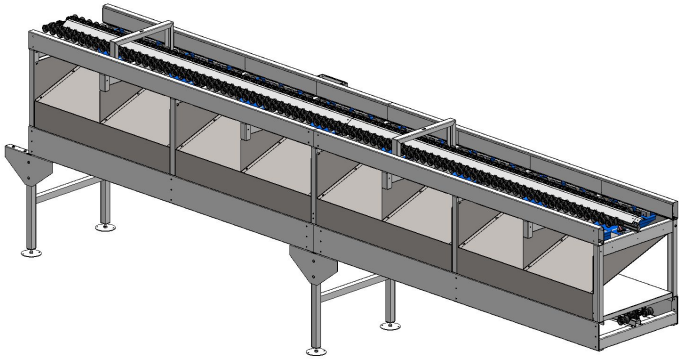




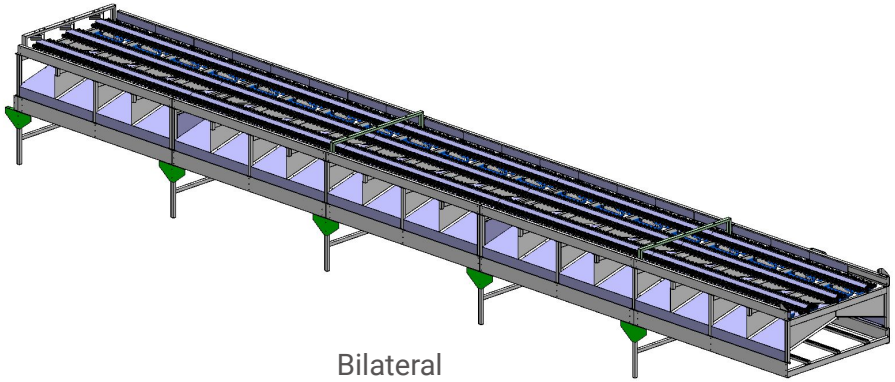




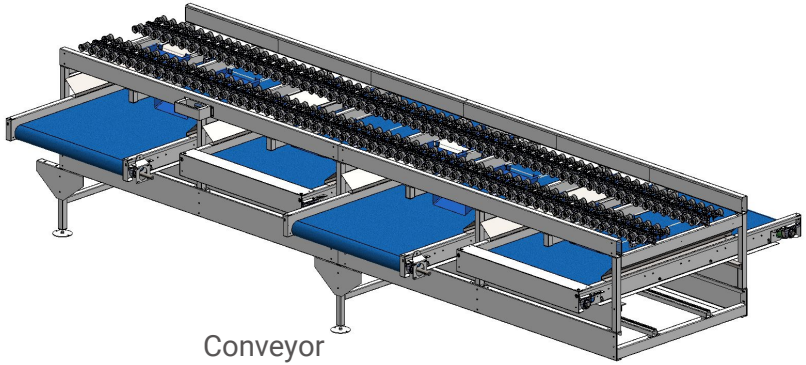
Outlets



Lateral

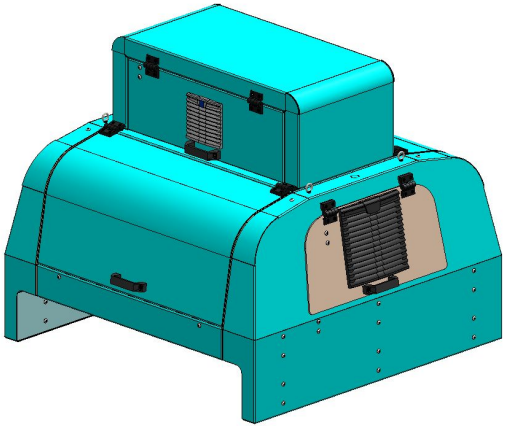


Bilateral

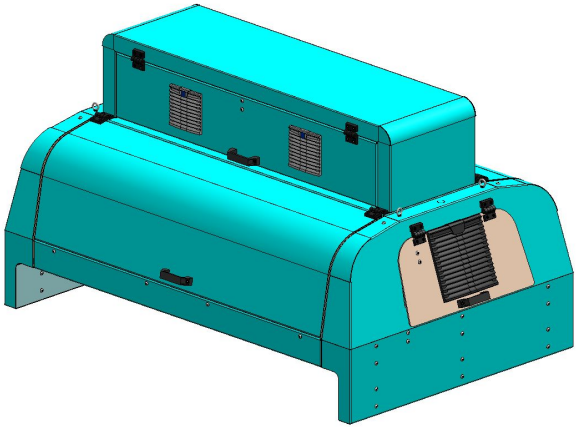


Conveyor

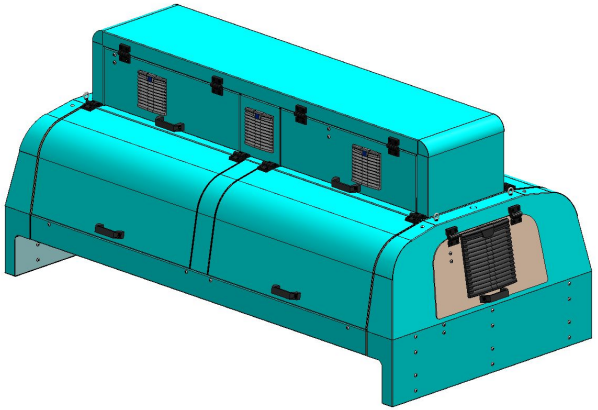
Camera cabinet



2 lines sorter



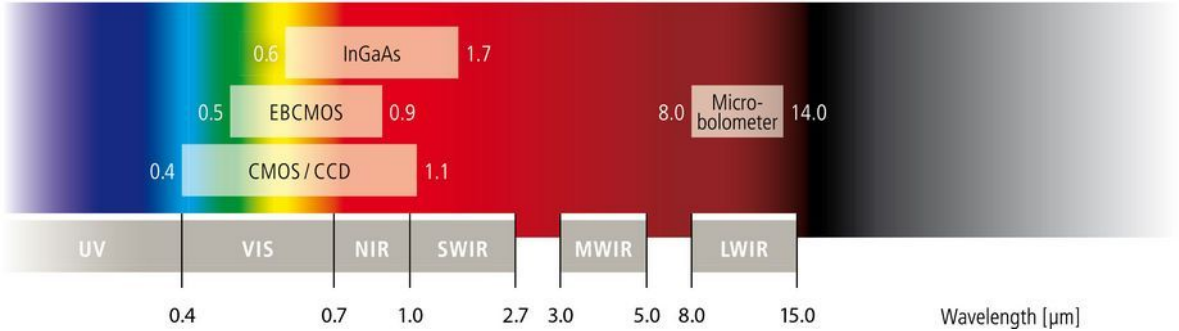
4 lines sorter

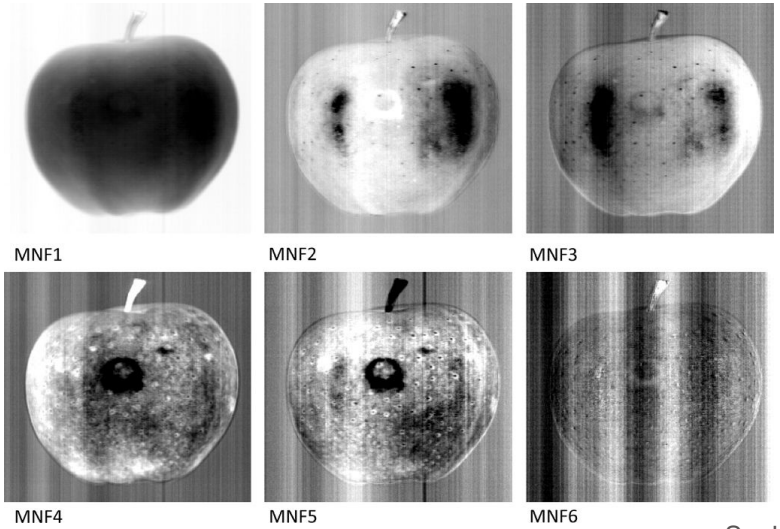


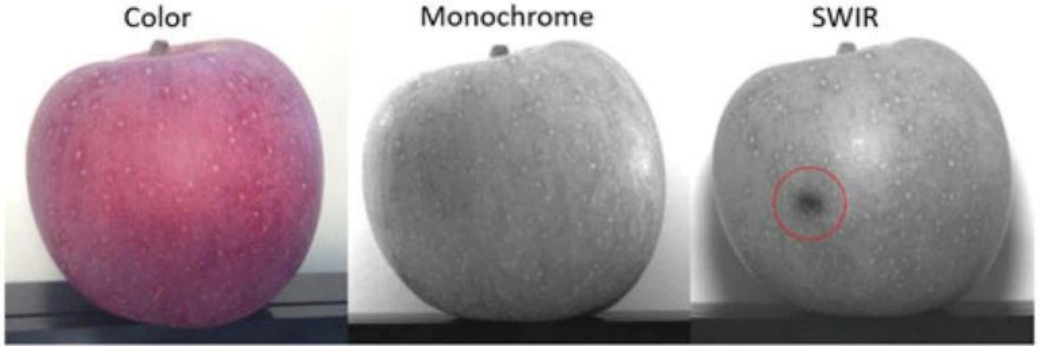
6-8 lines sorter

Espectro de Luz:

- Color
- Monocromática y/o NIR (Infrarroja)
- SWIR (Mayo penetración en la piel de la fruta)







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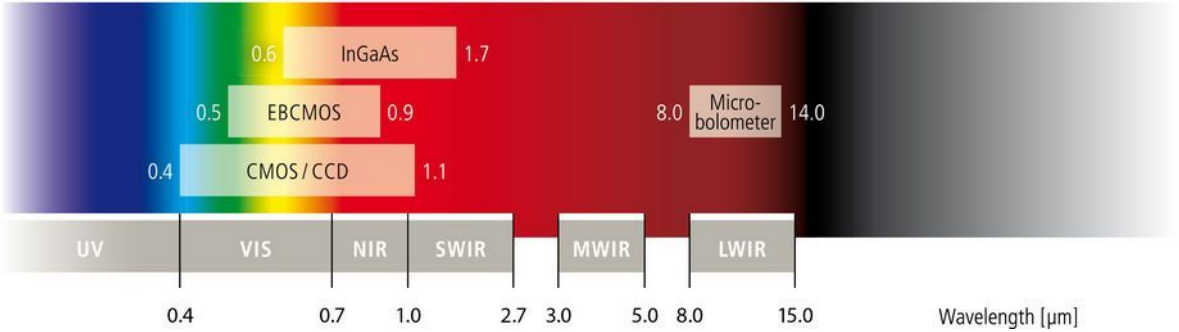
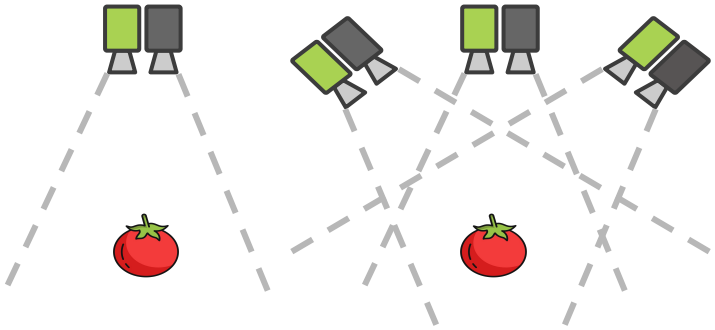
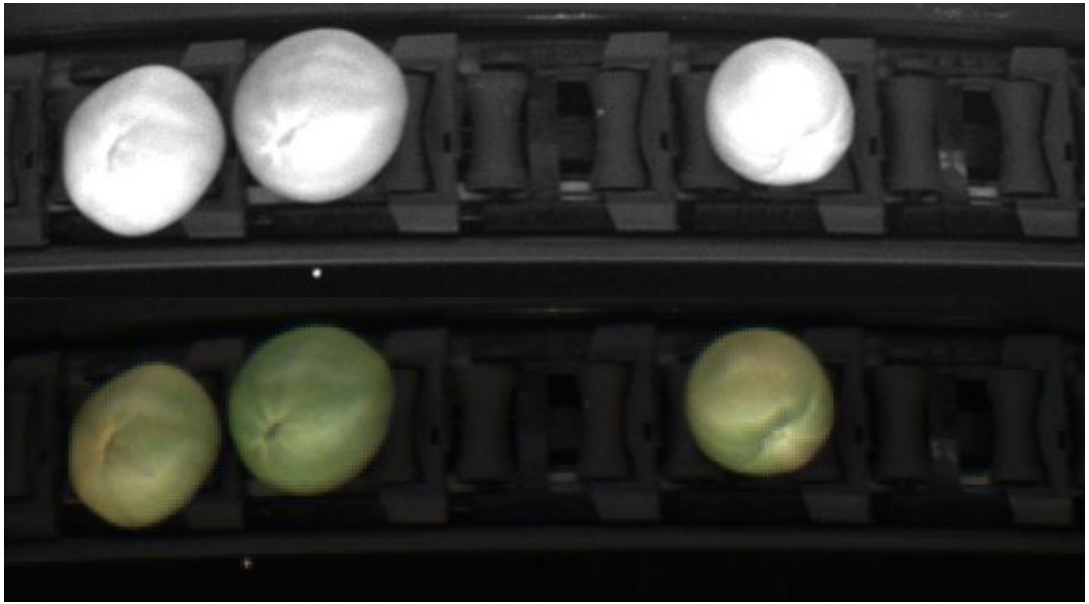


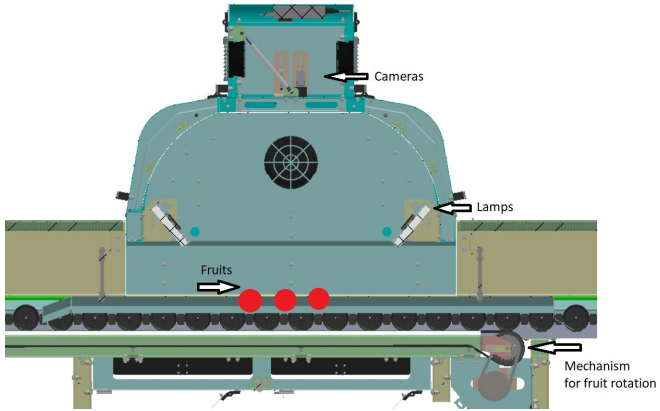


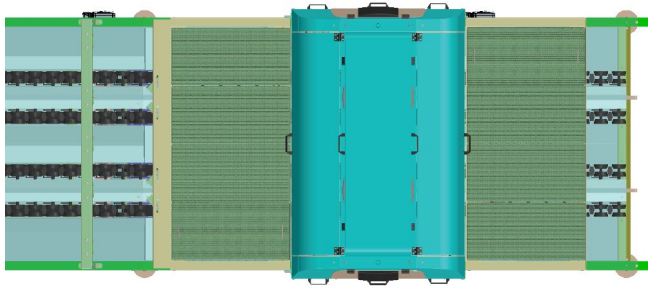
Top view

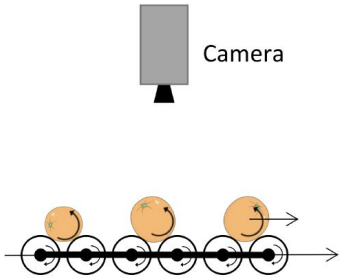
Full view

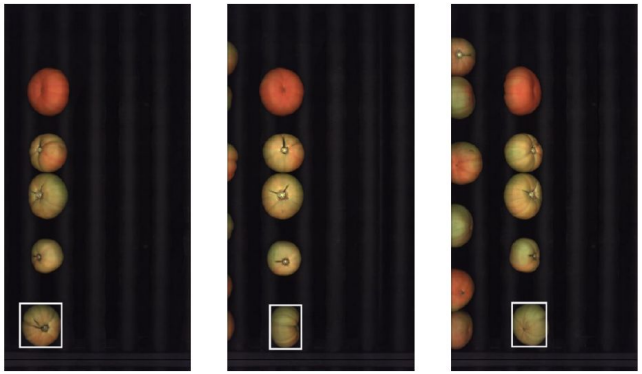


Usual camera technologies: ***Firewire*** **and** ***Ethernet*** **(GigE Vision)**.



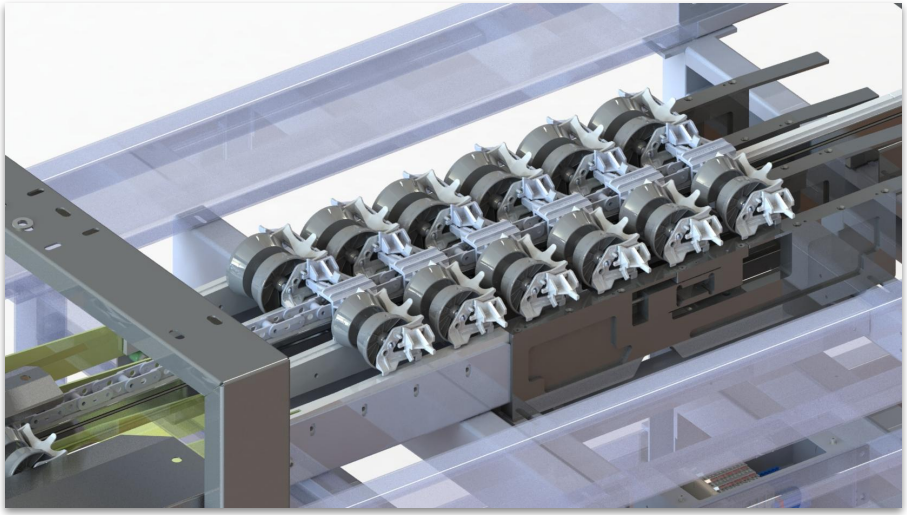




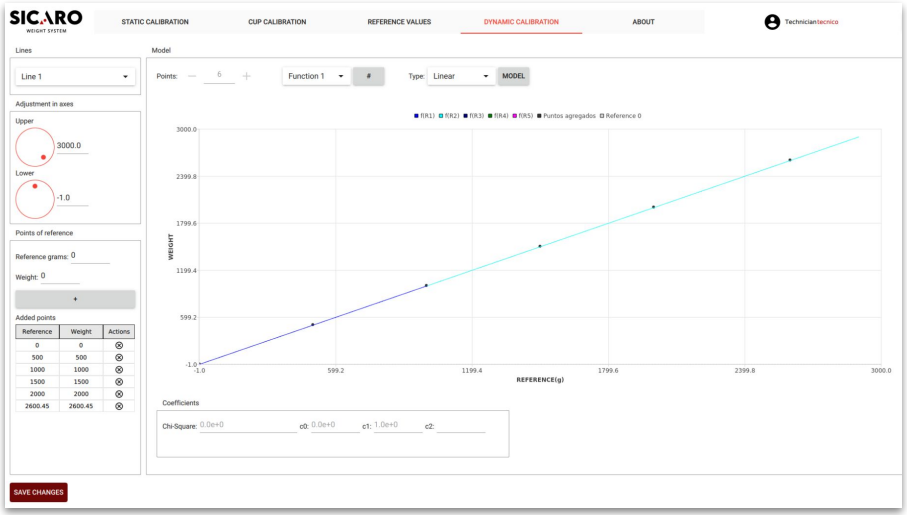


Pesaje

Módulo para clasificar por peso, puede ser combinado para estimar densidad



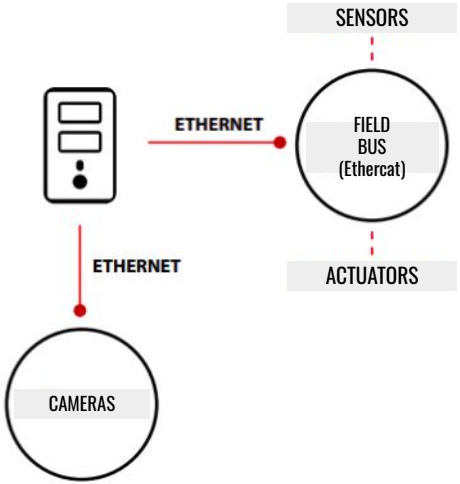
Diseño de carrier

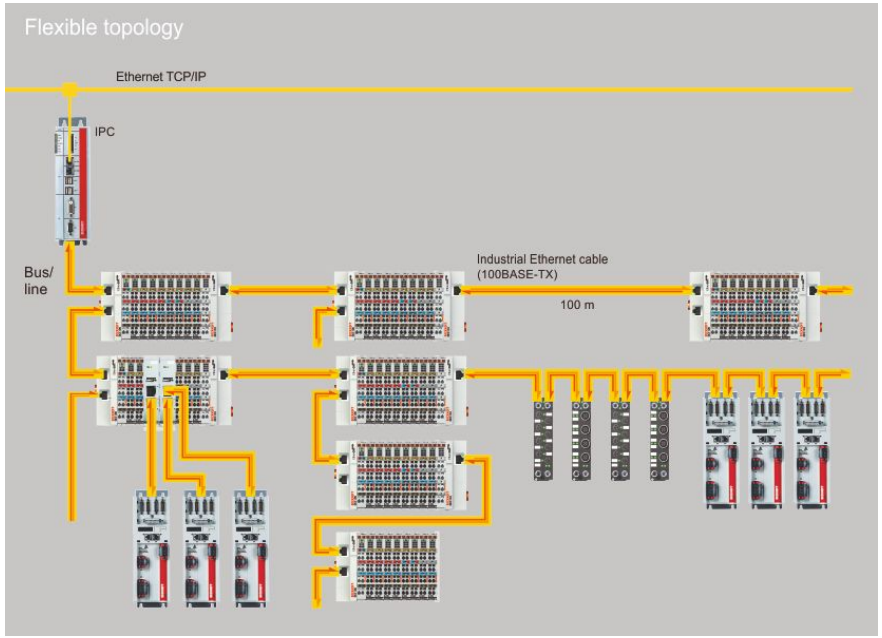


Software UI

Industrial control bus

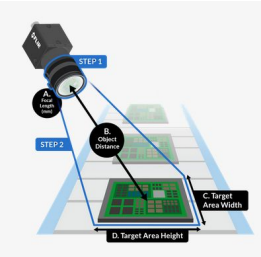
***Ethercat* industrial bus protocol, since they offer wide bandwidth of data with very fast access. Open source available.**





Mapa conceptual: Sistema de visión artificial para el control de líneas de tratamiento y selección de calidades

Camaras: Guppy (Allied Vision), DragonFly, Blackfly (PointGrey / FLIR)



Máquina: Controladores Beckoff (solenoides, sensor de rotación). Etiquetadoras.

FireWire / Ethernet

EtherCAT

PC Vision 1 (Ubuntu OS)

VISIÓN 1: Interfaz técnica para calibración de cámaras

EtherNET

PC Vision 2, 3, ... (Ubuntu OS)

VISIÓN 2, 3, … Se ha logrado correr 6 calles con una computadora

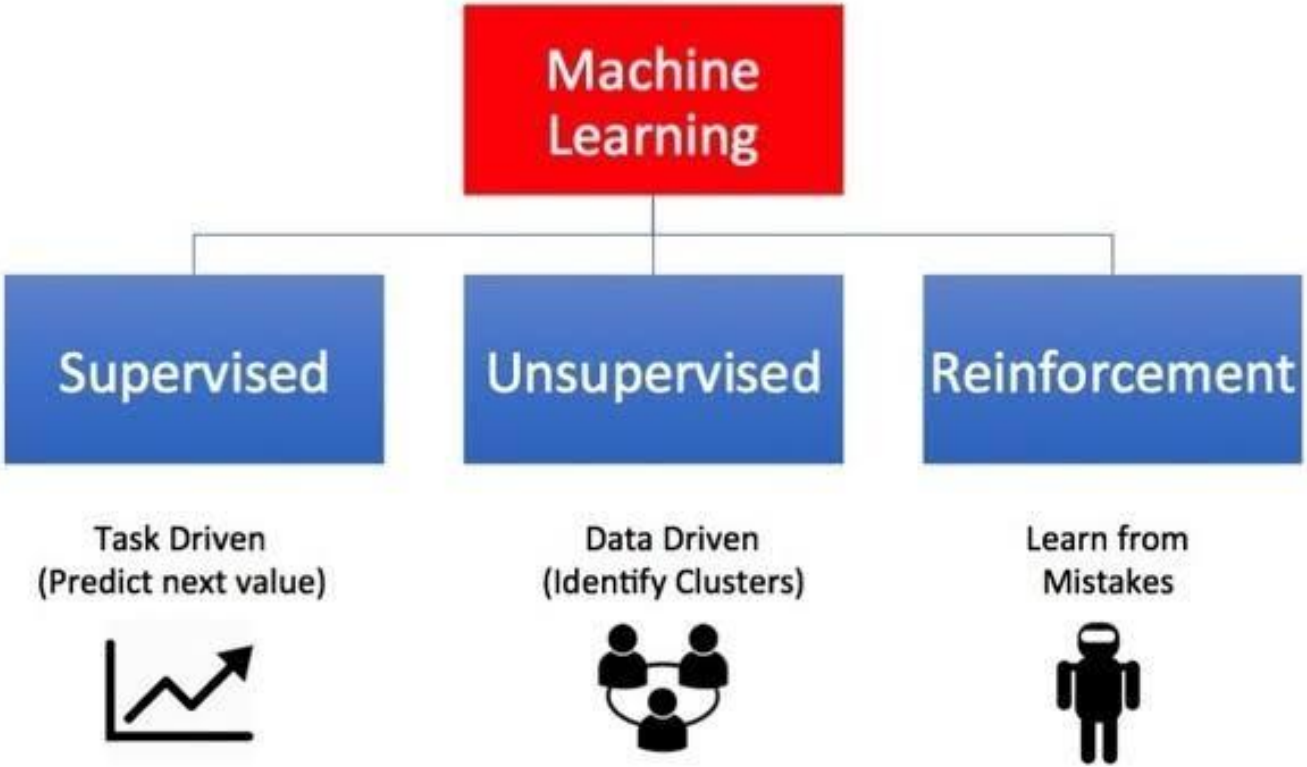
PC Principal* (Ubuntu OS)

SORTER: Interfaz principal, Programación de salidas

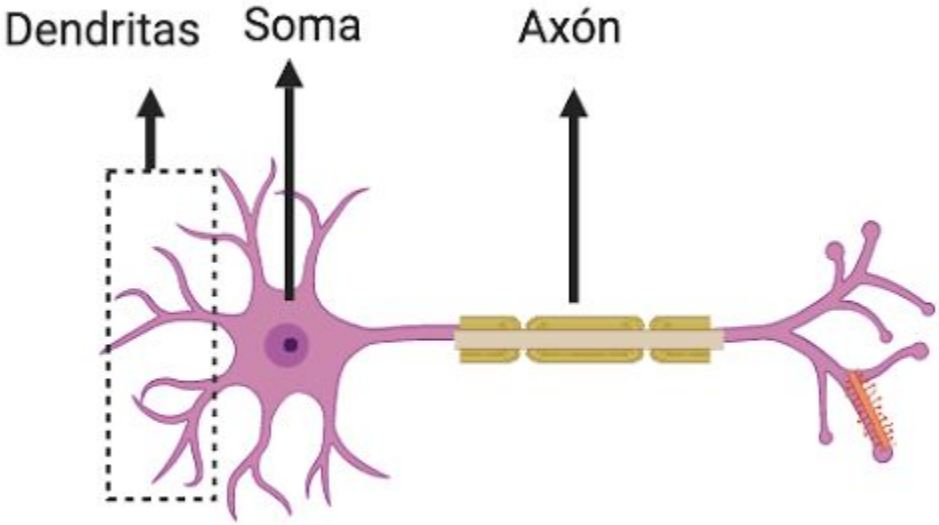
DATOS: Desplegado de "albaranes", gráficas de producción y rendimiento de la máquina

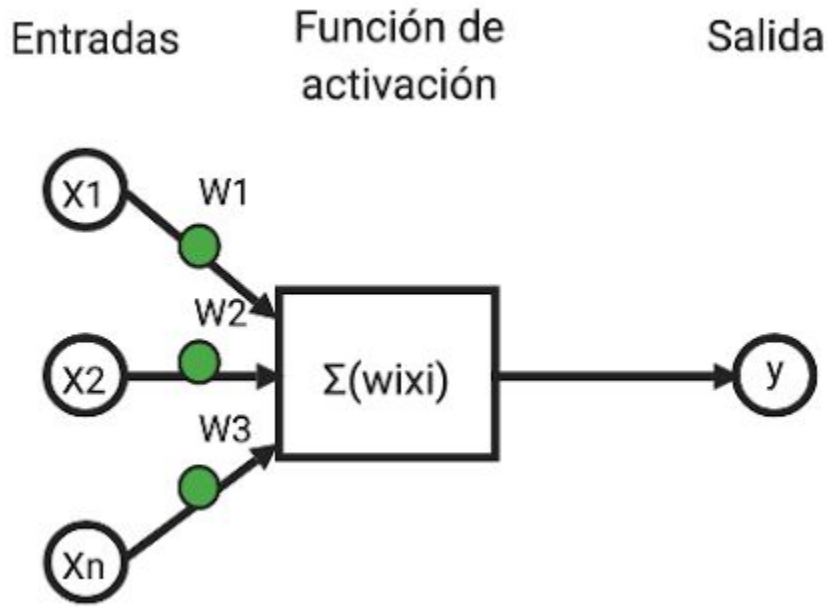
Disco

Types of Machine Learning

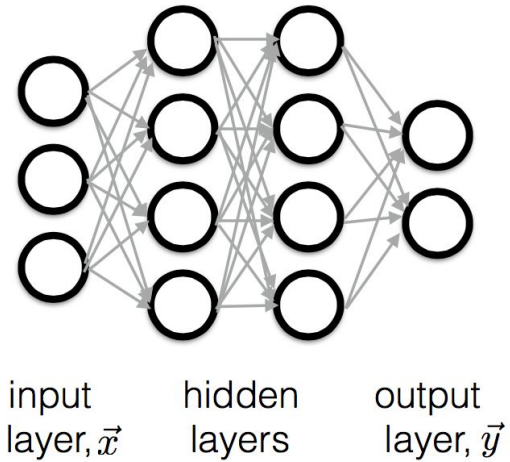


Redes neuronales, el perceptron

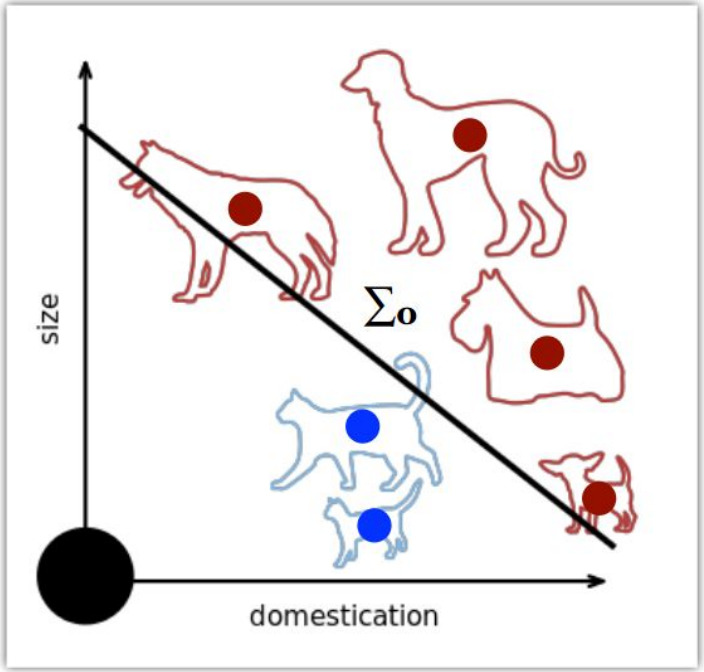




“Traditional neural net”
Fully-Connected Multi-Layer Perceptrons

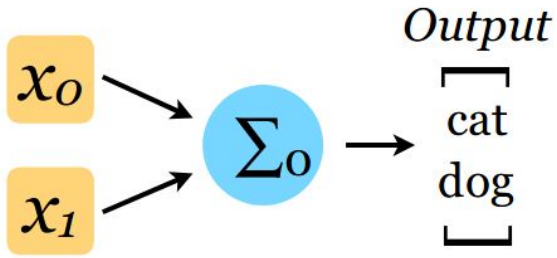


Imagine using two features to separate cats and dogs



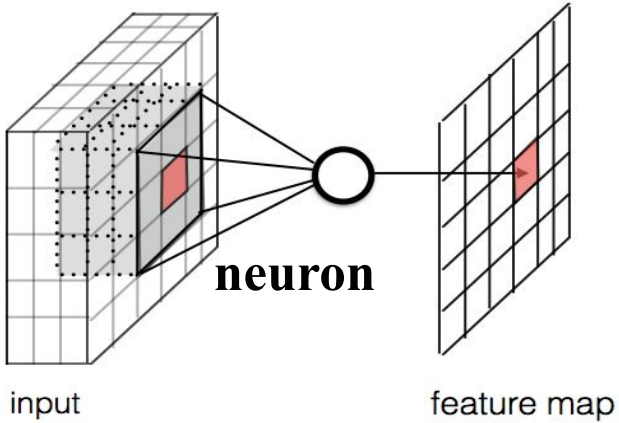
from [wikipedia]

$$\sigma(\vec{x}) = \begin{cases} \vec{w}_i \cdot \vec{x} + b_i & \vec{w}_i \cdot \vec{x} + b_i \geq 0 \\ 0 & \vec{w}_i \cdot \vec{x} + b_i < 0. \end{cases}$$

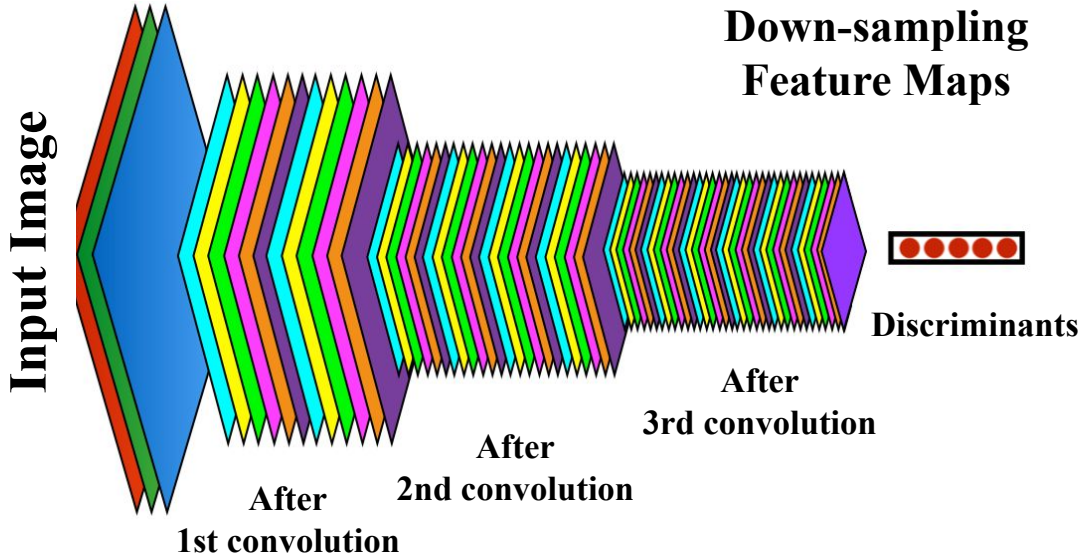


By picking a value for **w** and **b**, we define a boundary between the two sets of data

- **CNNs** are "**feature extraction machine**"
  - Consists of a "convolution layer" with "kernels"
  - A chain of parallelizable linear algebra operations
- **CNN** seen as a **geometrical data transformer**



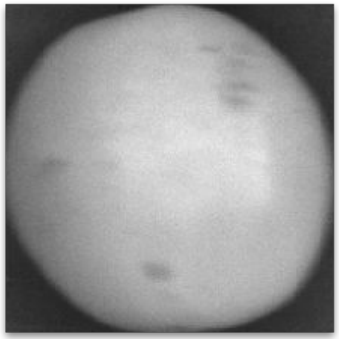
Convolution Operation



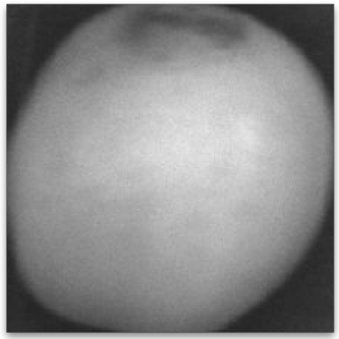
Series of convolutions + down-sampling

Skin quality classification using DL

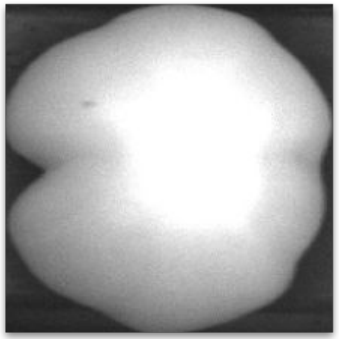
- Capacity to recollect high definition data base images during production to reuse, improve and adapt classification models.



Predicted label: Bad
Scarring



Predicted label: Bad
Localized bruise



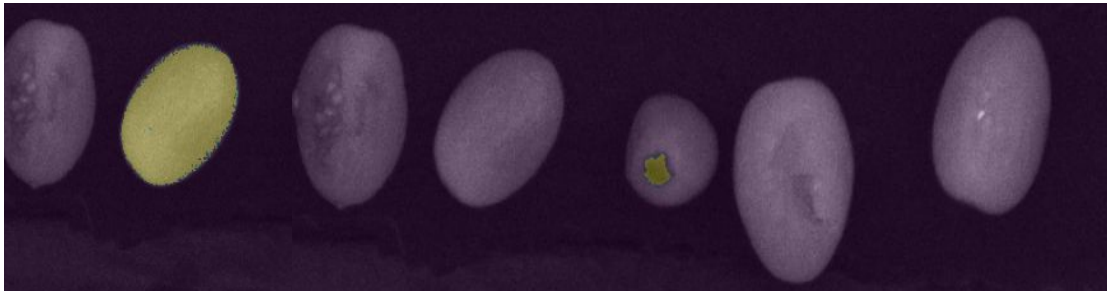
Predicted label: Bad
Deformation

TensorFlow Google Cloud OpenCV

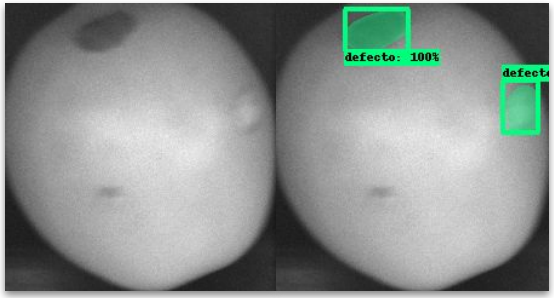
Pixel precision segmentation using DL

Quality detection with pixel precision: module for sorting fruit by pixel area. Customizable defects.
Levels of detection:

- Isolate fruit from background
- Color specific
- Texture specific
- Defect specific

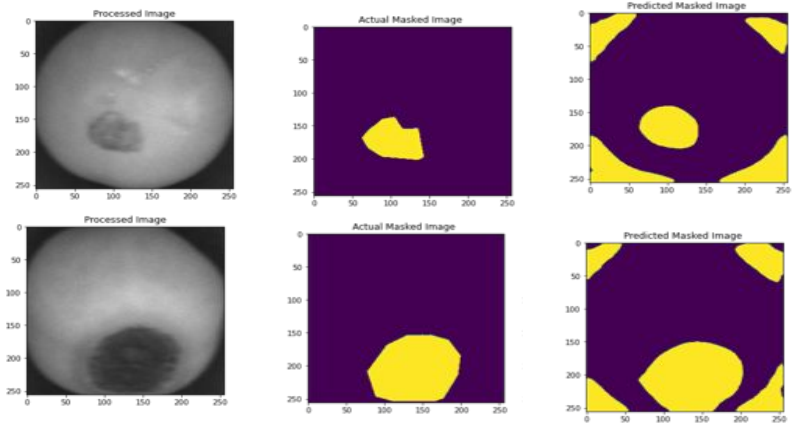


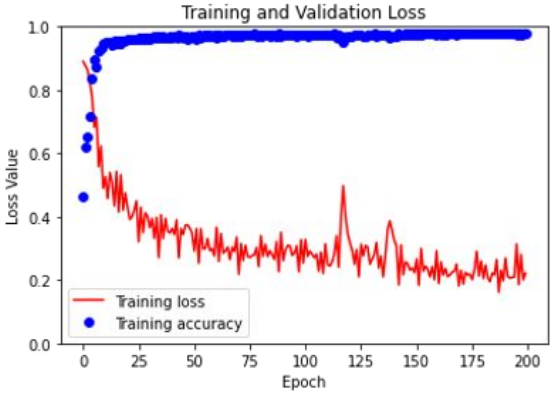
Fruit-background isolation and defect-fruit isolation example

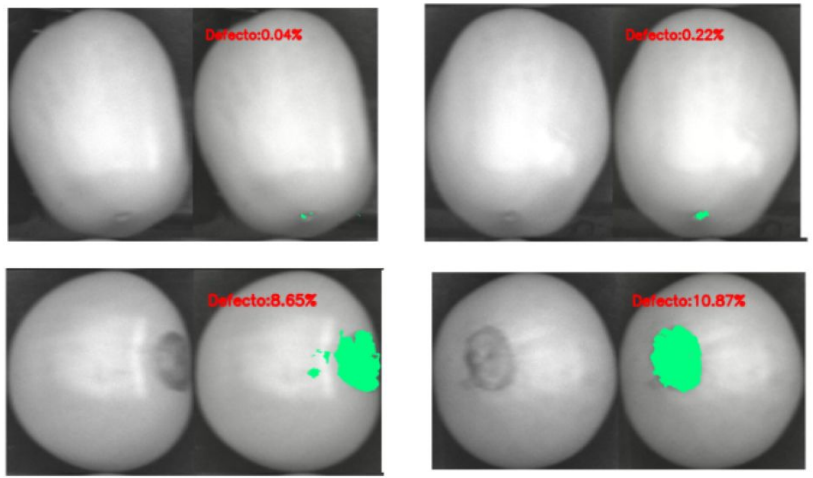


Pixel segmentation of defects

UNet para clasificación y segmentación

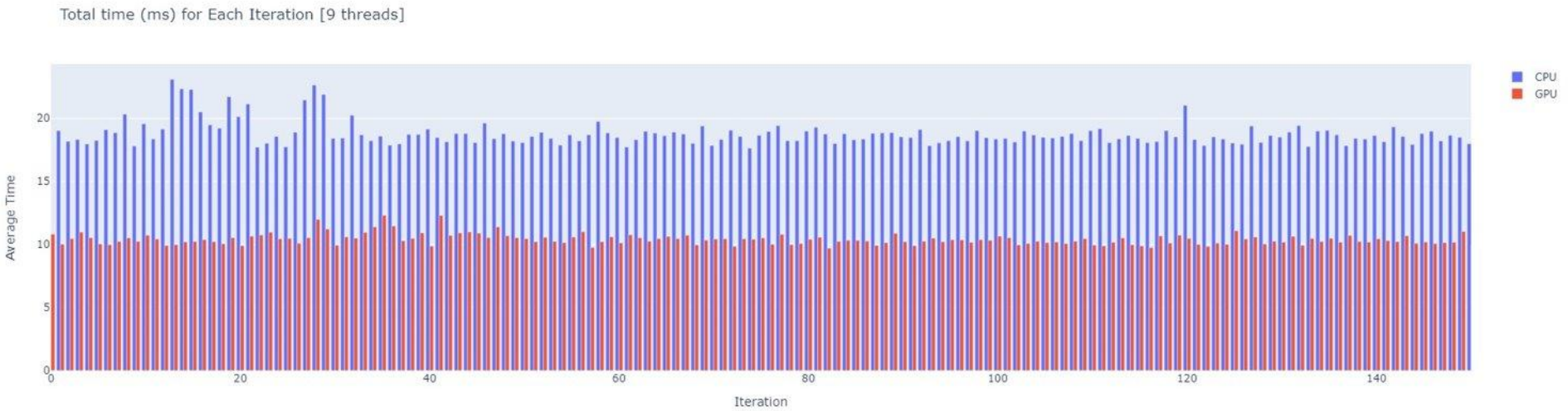






Segmentation demo frames with imperfection detection percentage

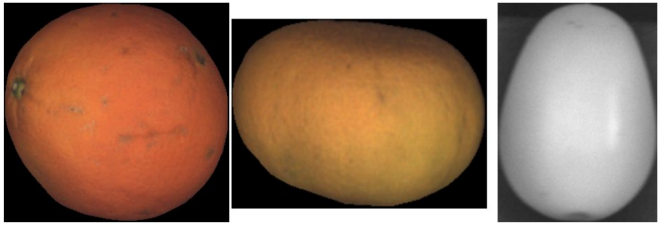
Performance, we need real-time inferences!

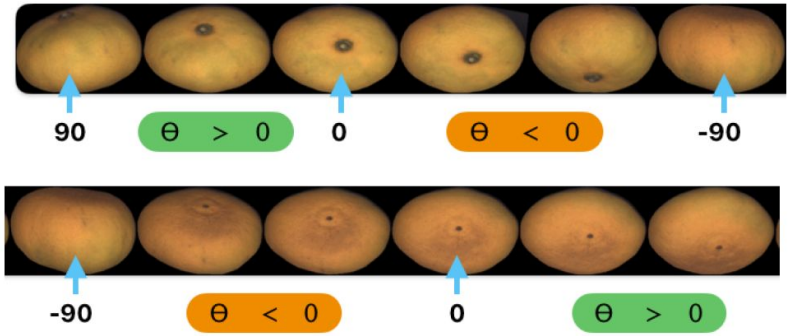


- 9 inferencias en paralelo
  - 20ms total en CPU intel i9 12 Gen, o approx 2ms por inferencia
  - 10ms total en GPU RTX-3070, o approx 1ms por inferencia
  -

Estimación de pose y radios internos

Spheroid models:
- Sphere (orange)
- Oblate (tomato)
- Prolate (cherry tomato)





Article

Fast 3D Rotation Estimation of Fruits Using Spheroid Models

Antonio Albiol [1,*], Alberto Albiol [1] and Carlos Sánchez de Merás [2]

Sensors 2021, 21, 2232. https://doi.org/10.3390/s21062232

Work by Tec de Mty students:

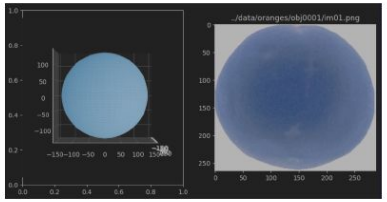


Fig. 3. Sphere spheroid compared with orange view

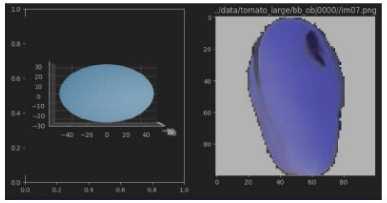


Fig. 4. Prolate spheroid compared with tomato view

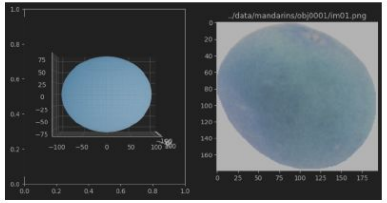
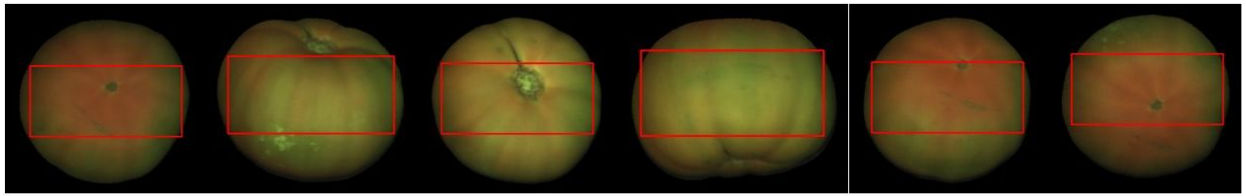
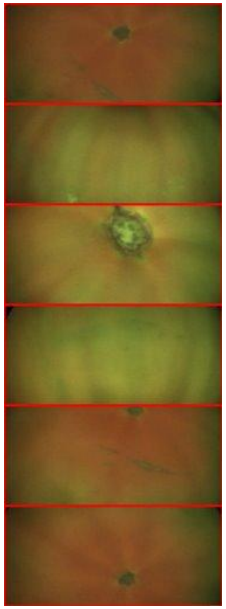


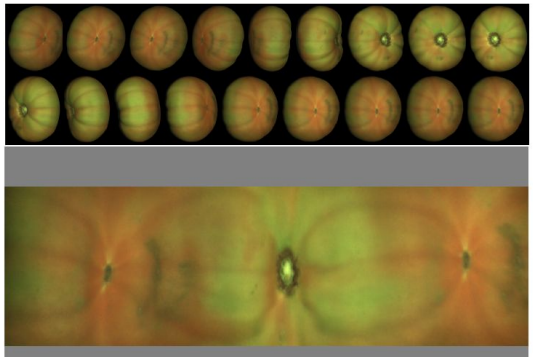
Fig. 5. Oblate spheroid compared with mandarin view

Fusión de imágenes

- Bajar el número de inferencias
- Porcentajes de segmentación de fruta completa y no solo de una imagen







Article

Single Fusion Image from Collections of Fruit Views for Defect Detection and Classification

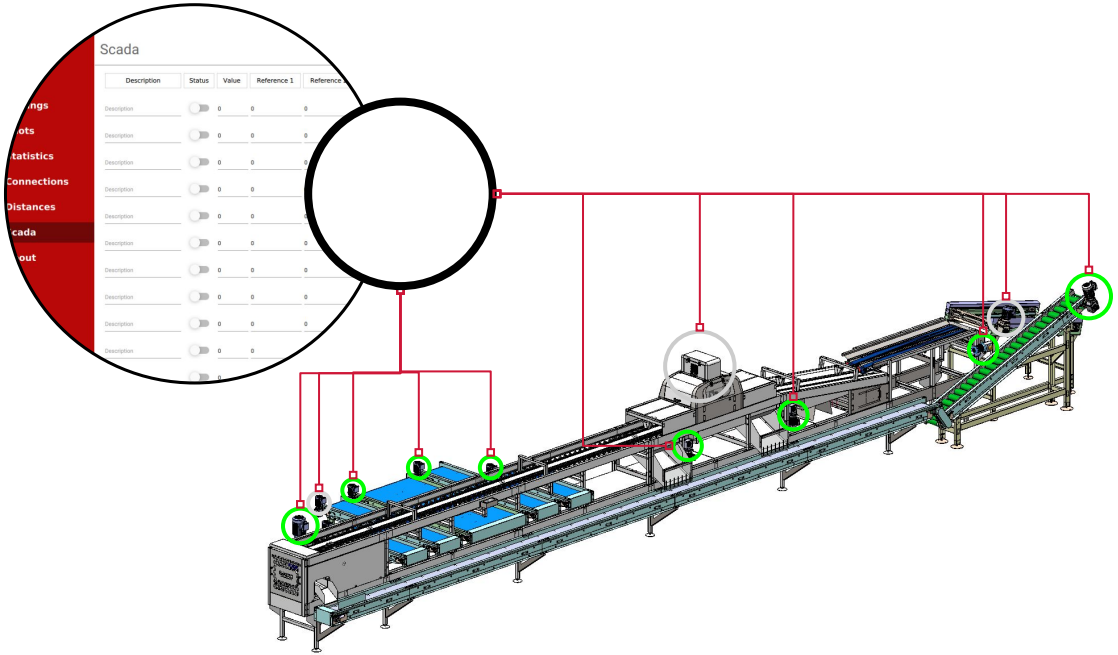
Antonio Albiol [1,*], Carlos Sánchez de Merás [1], Alberto Albiol [2] and Sara Hinojosa [3]

Sensors 2022, 22, 5452. https://doi.org/10.3390/s22145452

SCADA

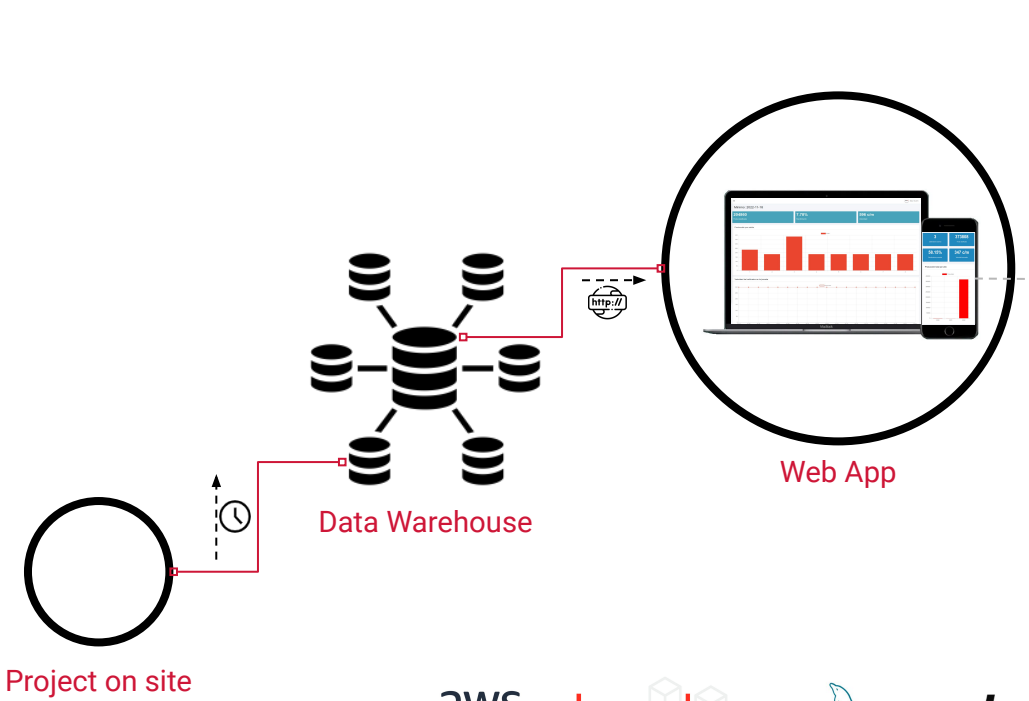
To control the entire treatment line:

- **L**ighting, motors, starts, shutdowns, etc.
- **P**erform automatic startup and shutdown sequences
- **AI** could be applied to predict failure

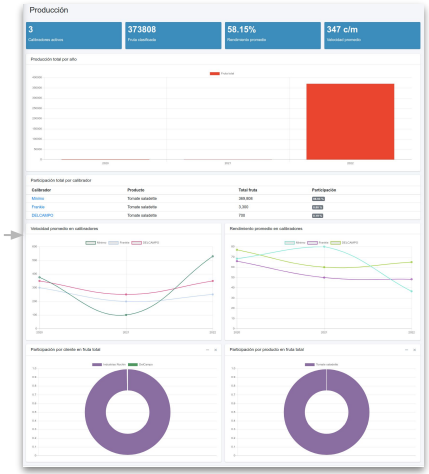


Power BI

Cloud-based business intelligence application: **offsite access**



Web User Interface



user: saul@rochin.com
pass: 12345678

Contacto. Quedo atento a sus comentarios :)